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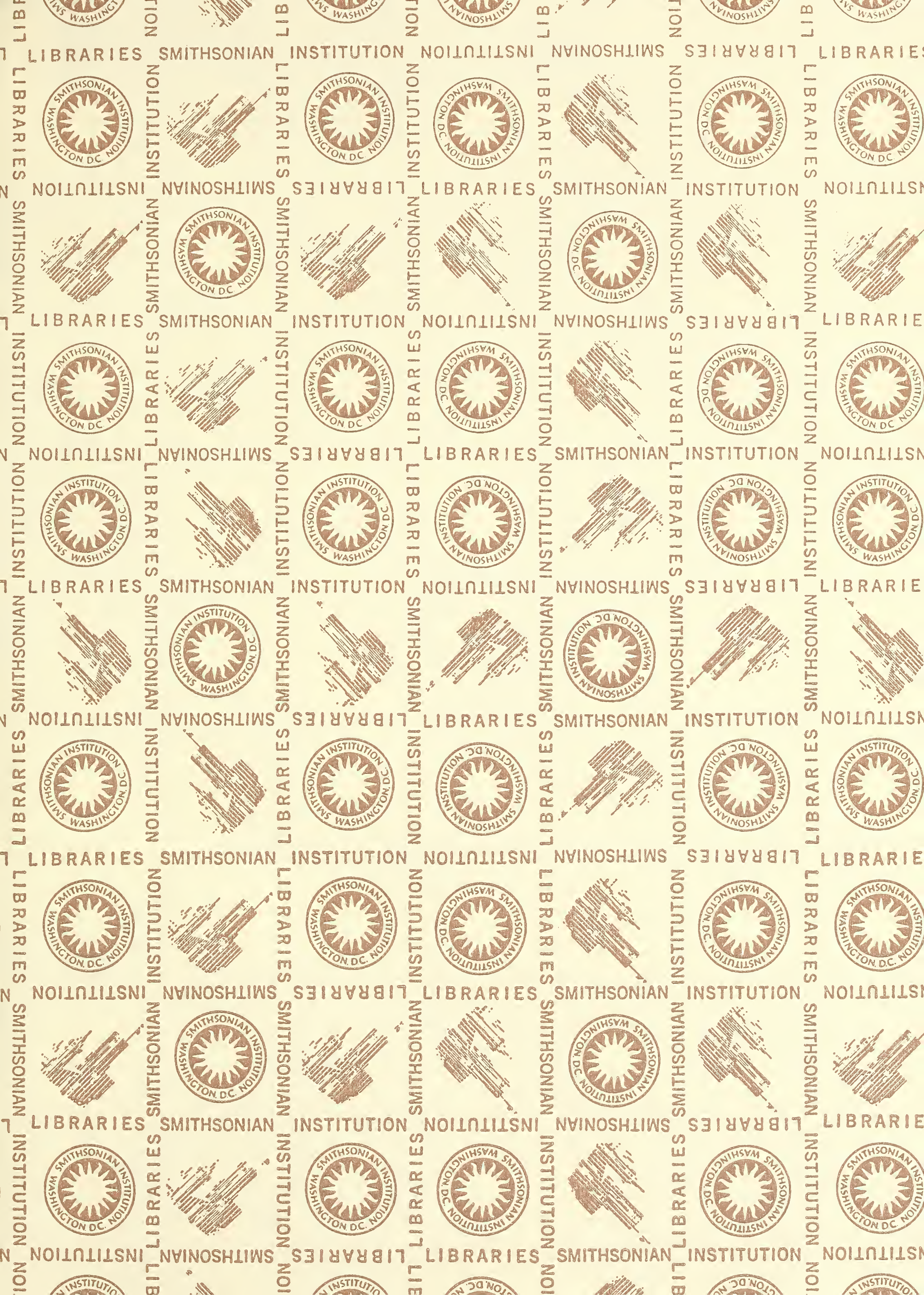
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BREEDING HABITS AND ASSOCIATED PHENOMENA IN SOME INDIAN BATS — PART XIV (CONCLUDED)[1]

A. Gopalakrishna and N. Badwaik[2]

Key words: bats, breeding, fecundity, gestation, mortality, sex ratio, sexual synchrony.

Different aspects of the breeding behaviour and associated phenomena in Indian bats are discussed, on the basis of earlier papers in the series. Basic reproductive patterns are genetically determined, but ecological factors may cause minor changes in breeding habits. The possible relationship between low fecundity and aerial habit is examined.

Questions relating to growth rate, longevity, sex ratio and preferential male mortality are discussed. Several species show adaptations, including various forms of sexual synchrony, to ensure population maintenance and species survival in spite of low fecundity and slow reproductive rates. Polytocous species have shorter gestation periods than monotocous species of comparable body size. The structure and functions of the penis are described.

Introduction

Each of the previous parts of this series of papers embodied descriptions of the reproductive habits of one of the Indian chiropteran species. From these reports it is evident that, while the breeding pattern is constant for a given species in a given geographical area, it differs markedly among different species inhabiting the same geographical area and under the same ecological conditions (Gopalakrishna and Sapkal 1986). Further, while some species, such as *Rhinolophus rouxi* (Gopalakrishna and Rao 1977) and *Hipposideros speoris* (Gopalakrishna and Bhatia 1983, Gopalakrishna *et al.* 1991, Gopalakrishna and Badwaik, in press) exhibit different reproductive patterns in different geographical regions with different ecological conditions. *Megaderma lyra lyra* (Gopalakrishna 1950, Ramakrishna 1951, Gopalakrishna and Badwaik 1990) breeds at the same time of the year in different parts of India with markedly different ecological conditions. Evidently, while genetic factors are mainly responsible for establishing the basic reproductive pattern of Indian bats, ecological factors, especially rainfall and availability of plentiful supply of food for the lactating females and weaned young, may bring about minor changes in their breeding habits.

Female Genitalia

In all the Indian bats so far studied the female genitalia are morphologically bilaterally symmetrical and consist of paired ovaries, bicornuate uterus and median vagina. In megachiropteran species the two cornua open independently into the vagina. Among Microchiroptera, in

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Taphozous longimanus (Gopalakrishna *et al.* 1979) the two uterine cornua open into the vagina in nonparous females by independent cervical canals. However, the tip of the cervical bulb breaks off during the first parturition and is never restored. Hence, in all parous females of this species the distal segments of the two cervical canals unite to form a common cervical canal.

In *Hipposideros fulvus fulvus* (Karim 1973) the vaginal epithelium extends to about half of the distal part of each 'cornu' — a condition which may be referred to as 'bicornuate vagina'. In most species the lumina of the two uterine cornua become confluent to form a corpus uteri which opens into the vagina by a common cervical canal. Although morphologically bilaterally symmetrical, the female genitalia of most Indian bats (except some vespertilionids) exhibit some degree of physiological asymmetry.

In *Rousettus leschenaulti*, *Cynopterus sphinx* and *Taphozous longimanus* the two sides of the genitalia function alternately in successive cycles. In hipposiderids the left side is partially dominant over the right and the majority of specimens ovulate and carry pregnancy in the left side. In *Megaderma lyra lyra* the left side is completely dominant over the right. In *Taphozous melanopogon*, *Rhinolophus rouxi* and all molossid bats the right side is completely dominant over the left. In those in which one side is completely dominant over the other, the contralateral side exhibits some degree of atrophy. The structural and physiological implications of the different kinds of female genital asymmetry were described and discussed by Wimsatt (1979) and Badwaik and Gopalakrishna (1990). The female genitalia are structurally and functionally bilaterally symmetrical only in some vespertilionids.

FECUNDITY

As a result of physiological asymmetry of the female genitalia most bats bring forth a single young one in each breeding cycle. Since most species breed only once a year their fecundity and reproductive rate are low. It is interesting to note that the two groups of vertebrates which have successfully adapted to aerial life, namely birds and bats, exhibit pronounced female genital asymmetry. In birds the right ovary is completely atrophied and the right Mullerian duct has degenerated. The reproductive rate and fecundity in most birds (except in the highly domesticated and anthropophilic species) are also low.

This interesting coincidence poses the question — is aerial habit responsible for the low fecundity in these two groups of animals? In bats, in any case, monotoky appears to be an important adaptation to their mode of life — nocturnal flying habits and diurnal inverted roosting posture — since these animals are confronted with an additional problem (not found in birds) of carrying relatively heavy foetus in the uterus and of carrying a relatively large and heavy young one attached to her breast during some part of the suckling period in most species. The weight of the full term foetus (and hence that of the newly born young) in relation to the body weight of the adult female is far higher in bats than in most other mammals (Table 1). From the table it is evident that the weight of the new born young is 20% to 30% of the weight of the mother, and in some vespertilionids, which deliver two or more young ones in each cycle, the total weight of the young ones at birth ranges from about 30% to about 57% of the body weight of the mother. The full term gravid uterus (with the weight of the placenta and other foetal membranes added) would be even more than the weight of the newborn young.

Carrying all this additional weight would be of considerable disadvantage to the pregnant female during her night foraging flights. Even during the resting position the weight of the gravid uterus during the advanced stages of pregnancy would have to be ultimately borne by the diaphragm. Hence, the pregnant mother would be under some degree of respiratory distress. Further, in most species the mother carries the young one incessantly attached to her breast during most of the suckling period (Table 1). The young one grows very rapidly in size and its weight increases two to three times during this period (Table 1). Carrying even a single young one of such a size and weight at breast would considerably hamper the aerodynamic efficiency of the mother. If more than one young is born the stress on the mother would increase significantly during both pregnancy and lactation. From an evolutionary point of view, therefore, it appears that female genital asymmetry with the consequent monotoky in bats might be an adaptation to meet their flying habit and unique resting posture.

The gestation period for bats is very long (Table 1) compared to the gestation period of other mammals of a comparable size. Among bats themselves, there is no direct relationship between body weight and duration of pregnancy as is evident from Table 1. Perhaps, because of the long gestation period, the newly born young is remarkably advanced in development, and it is quite active and able to crawl about actively on the body of the mother and anchor itself firmly to the mammary nipple by its jaws. The newly born young of monotocous bats are far more advanced in development and far more active than newly born young of polytocous species (Gopalakrishna and Madhavan 1972, Gopalakrishna *et al.* 1976, Ramakrishna 1976).

LONGEVITY AND SEX RATIO

The production of a single young a year by monotocous bats raises the question as to how these animals meet the problems of maintenance of population and survival of the species. Although no systematic work of banding for determining the longevity of Indian bats has been carried out so far, data on bats in Europe and North America reveal that some species live up to 20, and some even up to 30 years (Hill and Smith 1985, Robertson 1990). Bats appear to have a greater longevity than other mammals of corresponding size. On the basis of what is known about European and North American bats, and on the basis of an accidental recovery of ringed specimens of *Rousettus leschenaulti* and *Megaderma lyra lyra* after 14 years (Badwaik 1992), it is reasonable to assume that Indian bats may also have a longevity of 15 to 20 years. The monotocous species probably live longer than the polytocous ones.

In all Indian bats so far studied (with the probable, but still doubtful exception of *Taphozous melanopogon*) the sex ratio is even at birth and during the sucking period. But there is a preferential male mortality during the growth period, resulting in an unbalanced female-dominant sex ratio among adults. Table 2 gives the sex ratio at different phases of the life of some Indian bats. In *Taphozous melanopogon*, although reports have consistently indicated that males are more numerous than females (Abdulali 1949, Sapkal and Khamre 1984, Badwaik 1991), it must be mentioned that all these reports are based on the examination of specimens from one roost. Since this species is a seasonal migrator (Gopalakrishna 1986) and colonises in a given roost only in some seasons (Badwaik 1991), and since there is sexual segregation among the adults (Sapkal and Khamre 1984), the correct sex ratio in this species can be found out only after the examination of several colonies in different localities during all the months of the year.

GROWTH, MORTALITY AND POPULATION DYNAMICS

The young ones of bats grow very rapidly during the suckling period and reach a body weight of approximately two-thirds of the adult body weight in monotocous bats and half the weight of the adult in species which deliver two young ones (Table 1). The weaned bats also grow rapidly and attain adult body weight within a few months, but the age of maturity varies among different species. Most species reach sexual maturity and begin breeding within the year of birth, delivering their young when

TABLE 1
BODY WEIGHT, LACTATION, GESTATION, AGE OF MATURITY IN SOME INDIAN BATS

Name of species	Lowest wt. of female (g)	Highest wt. at birth (g)	No. of young in litter	Gestation period (in days)	Suckling period (in days)	Age of maturity in months		Highest wt. of attached young (g)	Authorities
						Male	Female		
Rousettus leschenaulti	55	12	1	125	35-40	15-16	5-8	37	Gopalakrishna & Choudhary 1977
Pteropus giganteus giganteus	650	58	1	140-150	—	—	—	—	Moghe 1950, this study
Cynopterus sphinx	50	11	1	120	30-35	15-16	5-8	35	Gopalakrishna & Sandhu 1984 Sandhu 1984
Taphozous kacchensis	50	14	1	96	—	20	9	16	Sapkal & Deshmukh 1985
Taphozous longimanus	24	7	1	—	—	—	—	14.6	Pers. obser.
Taphozous melanopogon	25	5	1	104	30-35	19-20	19-20	10-12	Sapkal & Khamre 1983 Badwaik 1991
Rhinopoma microphyllum	22	5	1	104	25-30	18-19	18-19	—	Pers. obser.
Megaderma lyra lyra	36	10.2	1	150	30-35	14-15	18-19	17	Gopalakrishna 1950, Ramakrishna 1951, Ramaswamy 1960, Gopalakrishna & Badwaik 1989, 1990
Rhinolophus rouxi	11	1.8-2.1	1	155	—	16	19	—	Gopalakrishna & Rao 1977
Hipposideros ater ater	5	1.5	1	195	25	18	6	2.1	Gopalakrishna & Madhavan 1978
Hipposideros fulvus fulus	10	2.5	1	155	20-22	18-19	18-19	4.0	Madhavan *et al.* 1978
Hipposideros lankadiva	55	9	1	260	30-50	16-17	16-17	22	Sapkal & Bhandarkar 1984
Hipposideros speoris	10	2	1	135-140	50-55	16-17	6-7	6.0	Gopalakrishna & Bhatia 1983, Gopalakrishna *et al.* 1991, 1992
Pipistrellus ceylonicus chrysothrix	7	1.2	2	50-55	25-30	9-10	9-10	3.2	Madhavan 1971, Pers. obser.
Pipistrellus dormeri	6	1.7	2	—	25-28	—	—	2.0	Madhavan 1979, Pers. obser.
Pipistrellus mimus mimus	2	0.5	2	—	—	—	—	1.5	Gopalakrishna *et al.* 1975
Scotophilus temmincki	38	6.5	2	105-120	—	7-8	7-8	—	Gopalakrishna 1947
Scotophilus heathi	36	5.5	2	105-130	24-28	5-6	5-6	23	Madhavan 1981
Miniopterus schreibersii fuliginosus	14	3	1	120	—	19	19-20	—	Gopalakrishna *et al.* 1985
Tadarida aegyptiaca	17	3	1	84	—	8-9	8-9	—	Kashyap 1980, Pers. obser.
Chaerephon plicata	21	4.5	1	85	—	—	—	—	Pers. obser.

they are a year old. In a few species, however, sexual activity does not commence until at least the second breeding season after birth. Hence, they deliver their first young at an age of at least two years. In a few species the age of sexual maturity varies between the sexes, females usually reaching sexual maturity at an earlier age than males. Table 1 gives the age of sexual maturity in some Indian bats.

There seems to be some loss of young during the latter half of the suckling period when the young start crawling about on the body of the mothers. During this period the young may lose its hold and drop from the mother, and not be retrieved. Even among species in which there is community suckling the young ones are sometimes lost since they crawl out of the niches (in which they are left by the mothers) and drop to the floor of the roost. Numerical data on mortality at this stage are not available. However, in species which carry the young almost for the entire period of lactation, the ratio of number of mothers in lactation to the number of attached young would give an approximate percentage of accidental loss of young. For example, in *Rousettus leschenaulti* and *Cynopterus sphinx*, for which data are available, the ratio of lactating females carrying the young at breast to those without young at breast in random collection of the specimens was 100:15 and 82:16 respectively. This would mean that there is approximately 13% loss of young in *Rousettus* and 16% loss in *Cynopterus.*

It must, however, be mentioned that some of the specimens, which were recorded as lactating mothers without babies, were in very advanced stages of lactation when the babies, were in very advanced stages of lactation, when the babies could have grown sufficiently to live independently. In fact, many free babies of both species had curdled milk in their stomachs, indicating that suckling continues for some time after the baby ceases to be attached to its mother's breast. Hence, the number of lactating females without babies attached does not represent the actual percentage of loss of young ones during the suckling period.

Specimens of *Rousettus* were found in a dark underground tunnel opening into a well and were caught in flight while they emerged from

TABLE 2

NUMBER OF SPECIMENS OF THE TWO SEXES AT DIFFERENT STAGES OF GROWTH IN SOME INDIAN BATS COLLECTED RANDOMLY (REPRESENTING ALL CALENDAR MONTHS)

Name of species	Sucklings		Pre-pubertals		Adults		Total
	Male	Female	Male	Female	Male	Female	
Rousettus leschenaulti	49	51	172	77	387	631	1367
Cynopterus sphinx	42	40	110	21	127	261	601
Taphozous kacchensis	4	8	24	68	45	96	245
Taphozous longimanus	10	19	—	—	40	116	185
Taphozous melanopogon	13	7	58	89	252	130	549
Megaderma lyra lyra	35	38	187	281	688	951	2180
Rhinolophus rouxi	—	—	38	26	141	201	406
Hipposideros ater ater	11	10	9	39	105	245	419
Hipposideros fulvus fulvus	20	26	47	67	137	325	622
Hipposideros lankadiva	10	8	26	76	158	244	522
Hipposideros speoris	39	33	96	43	276	824	1311
Pipistrellus ceylonicus chrysothrix	68	68	32	23	320	879	1390
Pipistrellus dormeri	15	17	25	140	148	328	673
Pipistrellus mimus mimus	23	20	43	226	203	402	917
Scotophilus heathi	43	43	34	27	293	517	957
Miniopterus schreibersii fuliginosus	87	93	302	58	706	1440	2686

their roost. Specimens of *Cynopterus*, which roost within groups of dried hanging fronds of palm leaves, were shot with an air gun during the day time. The difference in the roosting site and the manner of collection of specimens may also be responsible for the calculated figures of loss of young being slightly higher than the actual loss of young. Taking into consideration these facts the percentage of loss of young mentioned above, therefore, may at best be taken as the maximum possible loss of young during this phase of these life of the animals.

As mentioned earlier, there is preferential mortality of weaned males during the prepubertal phase, with the result that the adult sex ratio is biased towards females. In some species males form less than 20% of the adult population. Table 2 shows the number of specimens of the two sexes obtained by random collections during the different phases of the life of several Indian species. In *Rousettus* and *Cynopterus* the sex ratio during the prepubertal phase appears to be highly male-dominant. This anomaly is because females attain sexual maturity within the year of birth, the males do not attain sexual maturity until the beginning of the breeding season of the year following their birth, when they are at least 14 months old. Thus, while there are two 'crops' of prepubertal males there is a single 'crop' of prepubertal females. Hence, prepubertal males are far more numerous than prepubertal females in the colony.

It is thus evident that in all bats (except *Taphozous melanopogon*) there is a preferential male mortality leading to an imbalanced female-dominant sex ratio. In some species the imbalance is brought about during the prepubertal stage, and in others after attaining sexual maturity. The reason for this is not known.

Bats are relatively free from natural enemies. Their unique roosting posture and the very nature of their roosts (dark caves, tunnels and old buildings or almost inaccessible crevices in wells, rocks and tree trunks or concealed within palm leaves, etc.), keep them safe from predators. Their nocturnal flying habit also ensures safety when they come to open areas. Most incidents of predation on bats are due to chance encounters. Collisions with non-living objects resulting in the death of bats are also accidental and rare. Hence, unless man interferes with their life directly (as in some cases of fumigation of archaeological monuments) or indirectly (as due to heavy use of toxic insecticides) bats die of old age, barring accidents.

The factor of reproductive failure, which may affect population growth in some other mammals, needs to be addressed here. Reproductive failure may be due to many causes, such as copulation being unsuccessful or absent, failure of ovulation or ovulation being non-synchronised to insemination, failure of fertilisation, resorption of early embryos, abortion and so on. It is remarkable that bats have developed unique adaptations to overcome most of these problems. Taking only Indian species, storage of inseminated spermatozoa in the female genital tract as in *Pipistrellus ceylonicus chrysothrix* (Gopalakrishna and Madhavan 1971) and *Scotophilus heathi* (Gopalakrishna and Madhavan 1978) and storage of spermatozoa in the epididymis for two to three months after cessation of spermatogenetic activity in the testis as in *Hipposideros speoris* (Gopalakrishna and Bhatia 1983, Gopalakrishna *et al.* 1992) are adaptations to ensure fertilisation of the egg.

In all species except *Rousettus leschenaulti*, every adult female examined during the entire breeding season for several years was pregnant, thereby indicating that not only does every adult female undergo successful copulation, but it carries the foetus to its full period of gestation and delivers the young.

Only in *Rousettus* is there a loss of the foetus after mid-gestation only in her second pregnancy. This is probably because these females had experienced their first pregnancy when they were only five to seven months old, and could not carry a second pregnancy to full duration because of their young age. After this cycle the female brings forth two litters with one young each in every pregnancy cycle during the following years. Perhaps a similar situation obtains in *Cynopterus* too, as evidenced by the fact that a few of the adult females had lost the foetus during the March-July pregnancy cycle.

The above observations are relevant to the maintenance of population and survival of the species in spite of low fecundity and slow reproductive rate. As mentioned earlier, most bats have a surprisingly long life. Taking the example of *Rousettus leschenaulti*, it has been shown that this species lives at least for 15 years. Females of *Rousettus* become sexually mature in the year of their birth, and produce two litters each year for 15 years. Allowing for the second pregnancy to end in abortion, plus infant mortality of 13% (vide supra) and an additional loss of two or three individuals due to accidents, each female should produce during her life span at least 20-22 young that survive to adulthood. Because of preferential male mortality adult males form only 38% of the total adult population (Table 2). Thus, there would be approximately eight males and 12-14 females living up to their full life out of the 29 young delivered by the original female.

From the above it is evident that normally there should be an annual increase in the population of the species by 1.3 to 1.5 per cent. Preferential male mortality indirectly increases the potential reproductive population, namely the females. This appears to be an additional mechanism to ensure survival and to increase the numbers in spite of low fecundity and reproductive rate.

The only way the species can meet the increasing population pressure is to form new colonies. There is some evidence to indicate that does in fact happen. The normal roost sites of *Rousettus* are natural caves and dark underground tunnels. A perennial presence of water in the cave or tunnel or in the close vicinity of the roost appears to be an essential prerequisite for colony formation. However, several colonies of *Rousettus* occur in man-made structures, especially underground tunnels, deep wells and dark, humid dungeons in ruined monuments. Evidently, this species has successfully colonised new kinds of roosting places. Many other species of bats have also adapted to new roosting sites which are not essentially characteristic of these species (Brosset 1962, 1963). Evidently, in most Indian bats there is an expansion of population both in time and space, and new roosts and colonies are formed if the population pressure increases beyond the optimum limit in any colony.

GESTATION PERIOD

Data concerning the gestation periods in several Indian species of bats are given in Table 1. Generally, the gestation period in bats is much longer than in other mammals of comparable size. There does not seem to be a direct relationship between the gestation period and the size of the bat. Badwaik (1989) showed that there are marked differences in the gestation period even among different species of *Hipposideros*. Polytocous species appear to have a shorter gestation period than monotocous species of comparable body size. Perhaps the longer gestation period in bats in general, and in monotocous species in particular, may be one of the factors responsible for the young to attain a higher degree of development than in most other mammals. From the point of view of general biological principles the special habits of these animals, namely nocturnal foraging flight carrying the young one(s) at the breast during at least part of the suckling period and roosting in dark places during the daytime, demand that the young should be delivered as a well developed baby capable of considerable muscular movements soon after birth, and capable of living by itself independently within a relatively shorter time than other mammals.

LACTATION AND SUCKLING

Soon after delivery (within a few seconds after the young one emerges from the vagina in most cases) the young one crawls about on the belly of the mother and anchors itself firmly to the mother's nipple with its teeth. In vespertilionids, in which two young are delivered within a short time of each other (Gopalakrishna and Madhavan 1972), the mother assists the young towards her mammary nipple. In *Rousettus, Cynopterus, Rhinopoma, Taphozous* and *Megaderma* the teeth of the young are sunk deep into the thick cornified epithelium of the mammary nipple. In species having pubic dugs, the young one often holds one of the pubic dugs with the teeth and embraces the neck of the mother with its hind limbs during the non-sucking periods. In *Miniopterus schreibersii fuliginosus* and *Rhinolophus rouxi*, which live in relatively large colonies inside deserted caves and man-made tunnels or wells, the young one is carried by the mother only for a couple of days. Subsequently the young are kept in groups of five to 20 in *Rhinolophus rouxi* and 50 to 500 in *Miniopterus schreibersii fuliginosus* in niches in the walls of the roost. Lactating mothers visit these groups of young ones periodically and suckle them on a community feeding basis without there being any mother-young choice. In *Hipposideros speoris*, although the young one is left behind in the roost when the mother goes out for foraging, the mother and young recognise each other, and the mother suckles only her baby.

SEXUAL SYNCHRONY AND ADAPTATION

In most Indian species, which breed in a sharply defined season, males and females come to sexual activity nearly synchronously on the approach of the breeding season — the spermatogenetic activity in the testis and the activity of the male accessory glands commencing a few days earlier than the time of onset of changes in the female. Thus, the males are already in rut when the females come to heat and copulation is nearly always successful. However, in a few species there are special adaptations in the two sexes to ensure successful copulation leading to conception.

In *Pipistrellus ceylonicus chrysothrix* and *Scotophilus heathi*, although males and females are in rut and heat respectively synchronously (Gopalakrishna and Madhavan 1971, 1972) and copulate, ovulation is postponed by a few weeks, and during this period the inseminated spermatozoa are stored and remain viable inside the genital tract of the female and successfully fertilise the oocytes released five or six weeks after insemination. In *Hipposideros speoris* at Chandrapur, in which deliveries occur from May to July and the young reach sexual maturity when they are about eight months of age, the parous females copulate and conceive in December. However, the primiparous females, which attain sexual maturity in January, February and March, are also served by males in which spermatozoa are stored in the epididymis, and the accessory glands are maintained in a high state of activity until April, although spermatogenesis ceases by the end of December.

It is interesting to note that in this species the adult sex ratio is extremely unbalanced (25% males, 75% females). Evidently, the storage of spermatozoa in the epididymis and the maintenance of high state of activity by the accessory glands are adaptations to meet the differences in the time when the females attain sexual maturity and to overcome the disadvantages of an extremely abnormal female-dominant sex ratio. At a physiological level it appears as if the spermatogenetic activity in the testis and the secretory activity in the accessory glands in male *Hipposideros speoris* at Chandrapur are under different endocrinological mechanisms from those in males of this species inhabiting western Maharashtra and Marathwada regions, where the two parts of the male reproductive apparatus come into activity synchronously, resulting in the rutting period being restricted to a sharply defined time in the year (Brosset 1962, Gopalakrishna *et al.* 1991).

The structure of the penis deserves mention here since it presents special features in these mammals. Copulation occurs a posteriori. Except in a few species, which roost with their ventral body surface apposed to the supporting surface, most bats hang freely, and nearly in all Microchiroptera, there is an interfemoral membrane of variable expanse. The bats have to overcome the interfemoral membrane in a freely hanging unstable situation. In all Megachiroptera and most Microchiroptera, apart from a baculum or os penis (penis bone), which helps in maintaining rigidity of the tip of the penis for effective intromission, there are numerous backwardly directed spines on the glans penis and/or accessory corpora cavernosa, which swell considerably after intromission. The accessory corpora cavernosa act in a manner similar to the bulbus glandis in canid carnivores, and the spines on the glans penis become anchored to the vaginal epithelium during copulation. These structures are evidently adaptations to prevent premature separation of the pair in copula.

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FOOD AND FEEDING HABITS OF THE SOUTHERN CROW-PHEASANT *CENTROPUS SINENSIS PARROTI* STRESEMANN (AVES : CUCULIDAE) AT PT. CALIMERE, TAMIL NADU[1]

V. NATARAJAN[2]

(With three text-figures)

Key words: *Centropus sinensis*, crow-pheasant, *Cryptozona bistrialis,* feeding habits.

The food and feeding habits of the southern crow-pheasant *Centropus sinensis parroti* were studied from a village ecosystem. The crow-pheasant forages on trees, on the ground and also under bushes, feeding mainly on animal matter. Seven feeding methods and 30 food items were recorded. The foraging height on trees varied from 0.3 to 7.6 m. Seasonal changes in the diet were observed. The snail *Cryptozona bistrialis* was the most favoured food item. The frequency of predation on birds' eggs and nestlings was very low. The food items fed to its nestlings were recorded. The feeding association with other bird species is discussed.

INTRODUCTION

The food and feeding habits of the southern crow-pheasant *Centropus sinensis parroti* have not been studied in detail. Jerdon (1877), Mason and Maxwell-Lefroy (1912), Gill (1924), Baker (1927), Ali (1934), Ali and Whistler (1936), Ali and Ripley (1983) and Sanjeeva Raj (1963) have recorded some food items. A detailed study was undertaken on the food and feeding habits of this bird as well as the food items fed to nestlings.

MATERIAL AND METHODS

The feeding habits of the crow-pheasant were observed in Kodikkarai and Kodikkadu villages (337 ha) situated adjacent to Pt. Calimere Wildlife Sanctuary (10°18′ N, 79°51′ E) in Thanjavur district (now Nagapattinam Quaid-e-Milleth district), Tamil Nadu. Observations were made through 8x30 binoculars. The food items were recorded by observing the feeding birds and each food item fed on by the crow-pheasant was treated as one observation. From the total number of observations the dietary preference was estimated.

This study was carried out from September 1986 to March 1989. Apart from this, from September 1987 to August 1988 twelve hours were spent in each month to study the behaviour of the species. During that period the feeding site preference, foraging method, foraging height, and feeding association with other bird species were recorded. Two nests of crow-pheasant, one with three and the other with four nestlings were watched during 1987 and 1988 breeding seasons to record the food items fed to the nestlings by the parents. As the crow-pheasant was seen frequently foraging on the ground, the monthly abundance of some of the possible food items such as ground dwelling arthropods and molluscs were sampled using a quadrat of 0.5x0.5 m size. 20 quadrats per site were laid in each month. The availability of these items per sq. m area in village were calculated.

RESULTS AND DISCUSSION

Abundance of arthropods and molluscs: The abundance of arthropods and molluscs per sq. m area in the village site showed significant variation between different months (Fig. 1). The crow-pheasant fed the nestlings largely on snails, which were abundant from December to April.

Feeding habits: The crow-pheasant

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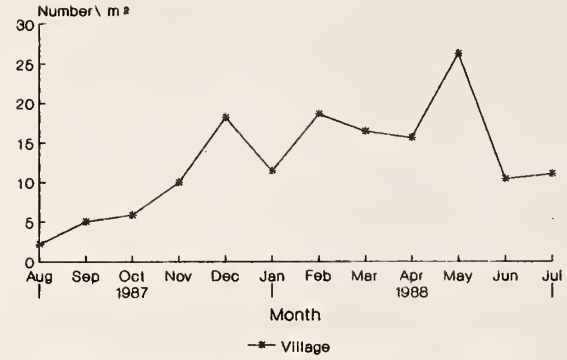

Fig. 1. Monthly abundance of arthropods and molluscs at the village study site.

predominantly feeds on animal matter. Mason and Maxwell-Lefroy (1912) occasionally found some vegetable matter (grass, leaves) in their stomach. Sanjeeva Raj (1963) recorded the crow-pheasant feeding on the fruits of yellow oleander *Thevetia neriifolia*. At Pt. Calimere the crow-pheasant spent considerable time foraging on the ground and under bushes. In trees, they hop from branch to branch in search of food. Roaches, beetles, ants and termites were picked up easily from the ground. Snails were eaten after breaking up the shell. Snakes were captured after a chase. Small frogs and lizards were swallowed whole, but larger prey were torn into pieces before eating.

Feeding sites and spots: The crow-pheasant forages on trees, on the ground, under vegetation, on leaf litter, on fence edges, on open grazing lands and also around houses on garbage heaps. On trees, they probe the holes of tree trunks and also in between tree branches. They also lift tree bark in search for food. The foraging height varies from 0.3 to 7.6 m (mean 2.8 ± 1.6 m, n=68). They very often glide from trees to the ground while foraging. To fly long distances they move to the top of the tree from where they glide and then fly. They normally fly short distances and sometimes when forced to fly, the progress is slow and laboured, with much flapping of wings and jerking of the tail. Even when walking, it has the habit of constantly

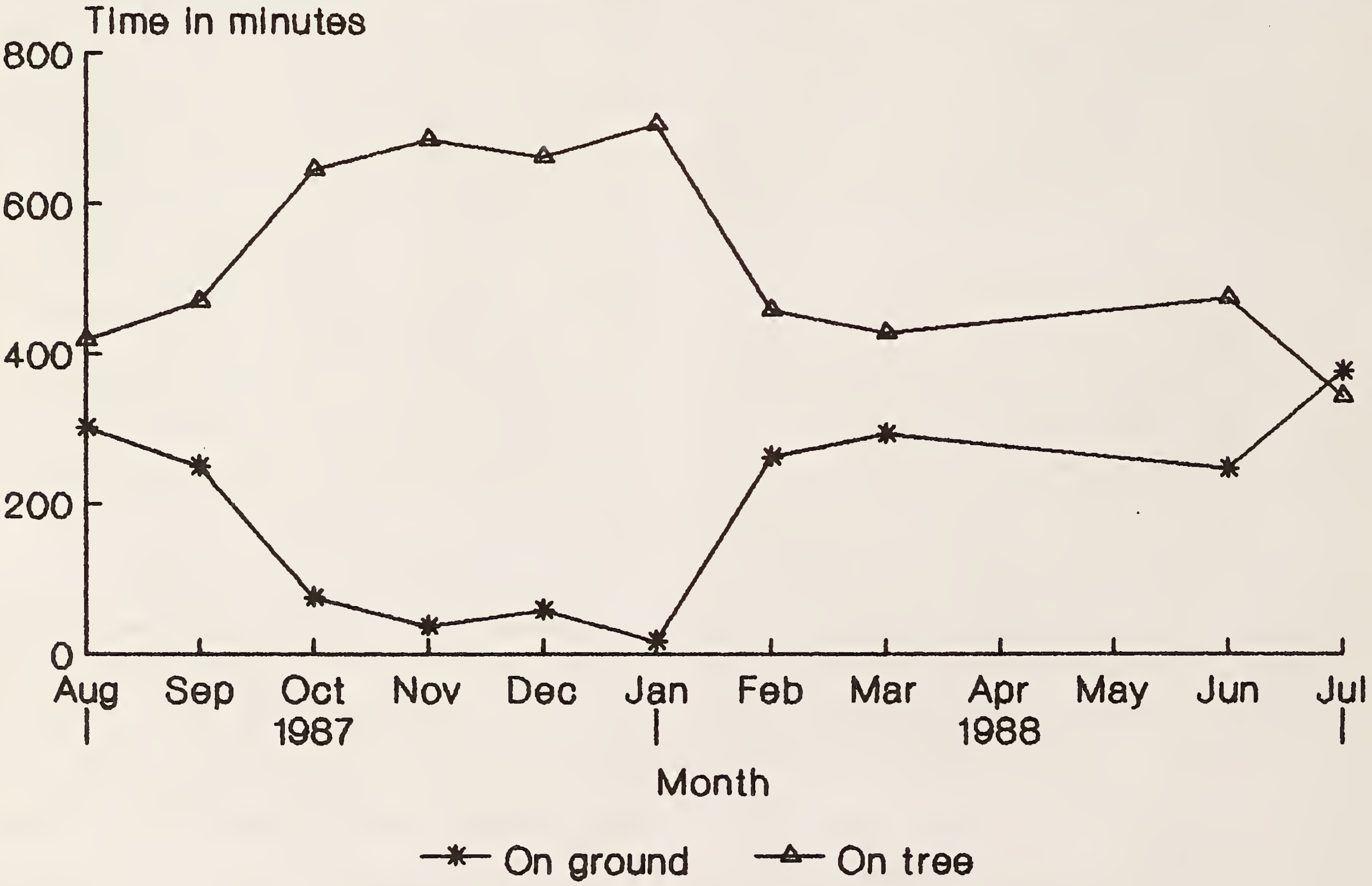

Fig. 2. Time spent on trees and on the ground by the crow-pheasant.

spreading its tail like a huge fan and jerking it up and down as mentioned in the case of common crow-pheasant *Centropus sinensis sinensis* by Baker (1927).

Time spent on trees and ground: The time spent on trees and on the ground, varies during each month (Fig. 2). On the ground it spent most of the time foraging and very little for various body comfort activities. More time was spent on trees than on the ground. However, while on trees they spent more time in comfort activities, calling and flying, than on feeding. While feeding on the ground it runs rapidly and also hops and jumps to capture prey. The lowest time spent on the ground was in January when the particular pair observed was engaged in incubation. As the crow-pheasant prefers snails for feeding the chicks, the time spent on ground increases after the eggs hatch. The time spent on trees was lowest (47.6%) in July and highest (97.8%) in January, when the bird was attending the nest. During April and May (hot months), it spent most of the time in bushes.

Methods of feeding: *Picking* — The birds picked up insects from the ground and trees and aestivating snails (*Helix vittata*) from the vegetation. The snails were eaten after breaking the shell. Beetles were eaten after removing the elytra. Insects like mantis were killed and eaten by holding them under the feet and pecking at them.

Probing — The bird probed in the holes on tree trunks, in between tree branches and bark to catch emerging insects.

Gliding — While feeding on trees, escaping insects falling to the ground were followed and captured by gliding to the ground.

Jumping and catching — During rainy season low-flying winged termites were captured by frequent jumps with a little flapping of the wings.

Chasing — Some grasshoppers and young garden lizards were captured after chasing for short distances on the ground.

Lifting of dead leaves — The birds lift the dry leaves and twigs and catch insects from the litter.

Flying and chasing – Tree-dwelling snakes were captured after chasing. Escaping snakes falling to the lower branches or to the ground were constantly searched for by hopping and flying among the vegetation or on the ground.

Food items: The crow-pheasant feeds on insects, snails, frogs and bird eggs and nestlings. About 30 food items were recorded (Table 1). The observations carried out from September 1986 to March 1989 have been grouped into three periods. (1) January to April, (2) May to August and (3) September to December. The frequency of food items recorded during each period is given in Table 2. Snails were the dominant food in all months. Ants were taken between May and August and termites during November. The garden lizard *Calotes versicolor*

TABLE 1
FOOD ITEMS OF THE CROW-PHEASANT

Gryllotalpa	*Gryllotalpa africana*
Beetle	*Agrypnus fuscipes*
Mantis	*Hierodula coarctata*
Grasshopper	*Crotogonus* sp.
Roach	*Therea pettiveriana*
Ant	*Camponotus compressus*
Snail	*Helix vittata,* *Cryptozona bistrialis*
Skipper frog	*Rana cyanophlyctis*
Bull frog	*Rana tigerina*
Tree frog	*Polypedates maculatus*
Common toad	*Bufo melanostictus*
Common garden lizard	*Calotes versicolor*
Brahminy skink	*Mabuya carinata*
Tree snake	*Dendrelaphis tristis*
Dumeril's blackheaded snake	*Sibynophis subpunctatus*
Buffstriped keelback	*Amphiesma stolata*
Common greenwhip snake	*Ahaetulla nasutus*
Sawscaled viper	*Echis carinatus*
Eggs and nestlings of redvented bulbul	*Pycnonotus cafer*
Eggs of ring dove	*Streptopelia decaocto*
Eggs of spotted dove	*Streptopelia chinensis*

Other items

Spider, earthworm, centipede, millipede, dragonfly, moth, caterpillar and grasshopper.

TABLE 2

FOOD ITEMS OF CROW-PHEASANT, FIELD OBSERVATIONS FROM SEPTEMBER 1986 TO MARCH 1989

Items	Jan. to April	May to Aug.	Sep. to Dec.	Total
Grasshopper	9	1	—	10
Mantis	—	1	—	1
Termites	—	—	25	25
Beetles	—	—	1	1
Roaches	—	1	2	3
Camponotus	—	46	—	46
Caterpillar	2	—	—	2
Millipede	1	—	—	1
Centipede	1	—	—	1
Spider	1	—	1	2
Snail	126	118	51	295
Frog	2	—	2	4
Calotes	5	2	1	8
Snake	2	2	1	5
Eggs of other birds	2	—	—	2
Nestlings of other birds	1	—	—	1
Drongo	1	—	—	1
Unidentified	10	5	4	19
Number of observations	163	176	88	427

and snakes were eaten all through the year. The frequency of predation on bird eggs and nestlings was very low. Two eggs, one each of ring dove *Streptopelia decaocto* and spotted dove *Streptopelia chinensis* were recorded being preyed upon. During February one nestling of redvented bulbul *Pycnonotus cafer* was taken from its nest by a crow-pheasant, then torn to pieces and fed to its fledglings.

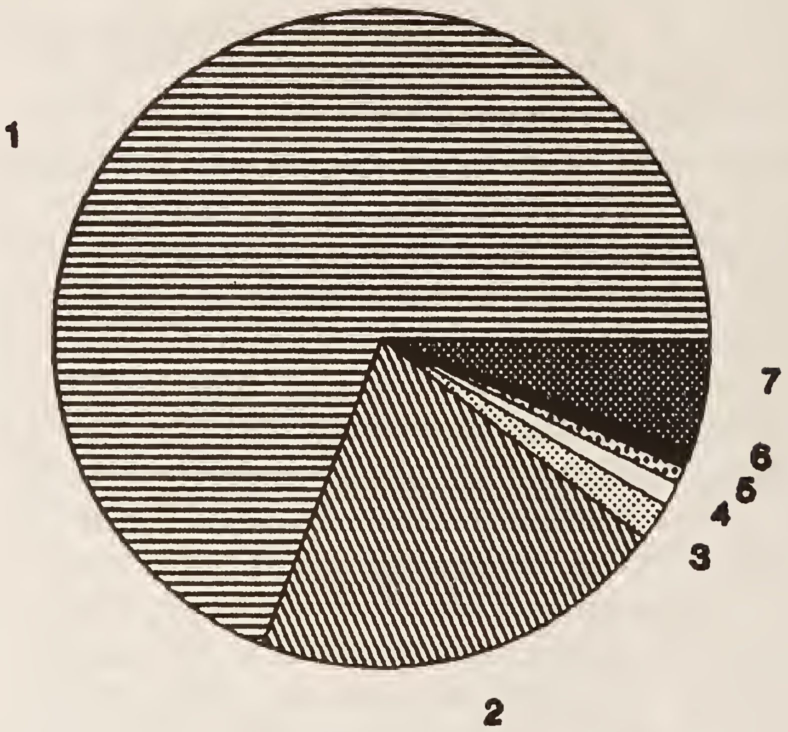

Fig. 3. Composition of diet of crow-pheasant. 1. Snails 69.1%, 2. Insects 20.6%, 3. *Calotes* 1.9%, 4. Snakes 1.2%, 5. Eggs and nestlings 0.9%, 6. Frogs 0.9%, 7. Others 5.4%.

The percentage composition of various food items is given in Fig. 3. Snails were the most dominant component of the diet (69.1%) followed by insects (20.6%). Items such as centipede, millipede, spider and unidentified food items were grouped under 'other items' (5.4%).

Food of nestlings: The food items fed to the nestlings of different ages were identified in the field from one nest each during 1986-1987

TABLE 3

NUMBER OF FOOD ITEMS FED TO THE NESTLINGS DURING DIFFERENT DAYS OF AGE (1986-1988)

Food items	Age in days																			Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
Earthworms	1	5	8	1	5	10	6	6	15	9	5	18	11	10	9	16	8	6	1	150
Arthropods	0	2	1	0	2	4	3	3	8	8	9	5	5	3	3	3	2	0	0	61
Snails	6	5	17	9	11	40	43	33	49	45	34	39	63	72	80	68	52	29	53	748
Frogs	0	1	0	0	2	10	13	6	5	11	12	13	17	10	3	4	5	2	1	115
Calotes	0	0	0	0	0	3	0	4	4	2	1	2	0	0	0	0	0	3	1	20
Snakes	0	1	0	0	1	1	3	1	3	0	0	1	0	0	1	1	0	2	1	16
Unidentified	0	0	2	2	11	0	7	2	8	4	3	8	7	4	5	5	9	2	7	86
Total observations	7	14	28	12	32	68	75	55	92	79	64	86	103	99	101	97	76	44	64	1196

and 1987-1988 breeding seasons (Table 3). The major food items for the nestling were two species of snails, namely *Cryptozona bistrialis* and *Helix vittata*. When the flooded areas around the nesting site dried up, the crow-pheasant brought skipper frogs *Rana cyanophlyctis* and earthworms from puddles to feed the nestlings. Initially they brought small frogs, large numbers of snails, and young garden lizards to the nest. Once a nestling was seen feeding on a garden lizard. The body of the lizard had been swallowed, and the tail (150 mm) was visible outside the bill, gradually being swallowed. The snakes were torn to bits and fed to the nestlings which swallowed them immediately. The snakes included the tree snake *Dendrelaphis tristis*, buffstriped keelback *Amphiesma stolata*, common greenwhip snake *Ahaetulla nasutus* and saw-scaled viper *Echis carinatus*.

The other items brought to the nestlings in small numbers were spider, centipede, grasshopper, mole-cricket, beetle, roach, caterpillar, moth, butterfly and dragonfly. The rate of feeding increases with growth of young. The nestlings need a protein-rich diet for growth and calcium for the development of bones, which the animal diet provides. Nestlings of other birds were not brought to feed the nestlings.

Feeding association: Normally the crow-pheasant feeds alone. On some occasions while feeding in marshy areas they were seen feeding along with jungle crow *Corvus macrorhynchos*, house crow *Corvus splendens* and common myna *Acridotheres tristis*. While feeding, the jungle crow gave considerable trouble to the crow-pheasant by pecking at its tail from behind. The crow-pheasant chased the jungle crow on several occasions, but such encounters ended with the two birds feeding in adjacent areas. In another instance the crow-pheasant was seen feeding on winged termites along with pied crested cuckoo *Clamator jacobinus*, Indian plaintive cuckoo *Cacomantis merulinus*, palm swift *Cypsiurus parvus*, Indian roller *Coracias benghalensis*, brown shrike *Lanius cristatus*, black drongo *Dicrurus adsimilis*, ashy swallow shrike *Artamus fuscus*, common myna, house crow and jungle crow.

The crow-pheasant is regarded as being highly destructive to the eggs and nestlings of other birds. However, this study with data collected mainly from a village ecosystem, found the assumption to be not totally correct. Its diet was found to comprise mainly of two snail species and other animals such as insects, lizards, frogs and snakes. Predation on birds' eggs and young was recorded to be very low and hence they do not play a dominant role in the nesting success of other species of birds. However, I have to add that this statement again may not be appropriate, as the birds studied belong mainly to a village ecosystem – in a forest ecosystem, there may be some differences.

ACKNOWLEDGEMENTS

This paper is based on my Ph.D thesis (University of Bombay, 1990). I am grateful to Mr. J.C. Daniel, former Curator, Bombay Natural History Society for his guidance and encouragement throughout the study period. I wish to thank Mr. S.A. Hussain and Dr. Asad R. Rahmani, for going through the draft and for their valuable comments. I acknowledge the suggestions given by Dr. Priya Davidar, Salim Ali School of Ecology, Pondicherry. I thank S. Karthikeyan and C. Balasubramanian for their assistance in the field. My thanks are due to U.S. Fish and Wildlife Service for providing funds for the project through the Ministry of Environment and Forests, Govt. of India. Finally I thank the officials of the Pt. Calimere Wildlife Sanctuary for their co-operation and help.

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COMMUNAL NESTING BY GHARIAL *GAVIALIS GANGETICUS* (GMELIN) (REPTILIA: CROCODILIA) IN NATIONAL CHAMBAL SANCTUARY[1]

R.J. Rao[2] and L.A.K. Singh[3]

(With four text-figures)

Key words: Communal nesting, *Gavialis gangeticus,* gharial.

Observations are presented on communal nesting in the gharial *Gavialis gangeticus* at two locations in National Chambal Sanctuary. Pre-nesting activities, spacing and location of nests and nest attendance are discussed. 23 nests were laid in late March and early April at the two locations. These were located on average at 7.7 ± 1.8 m from water. Clutch size for eight nests was 37 ± 11 eggs, and incubation period 64 ± 3 days. Hatching success was nil for one nest, and between 65.7% and 100% for seven other nests.

Introduction

The gharial *Gavialis gangeticus* is a communal nester, i.e. a number of females use the same sand bank to lay eggs. More than two nests occurring side by side have been reported earlier by Singh, L.A.K. (1978), Singh, V.B. (1978), Bustard (1980), and Whitaker and Basu (1982). These accounts do not reveal the spatio-temporal distribution pattern of nests and their hatching on a communal nesting ground, as described in this note based on our observations at the National Chambal Sanctuary.

Study Locations

The Chambal river constitutes a part of the Gangetic river system. The National Chambal Sanctuary, declared over the Chambal river, holds the best surviving population of *G. gangeticus.* Out of 10 nesting sites identified in the sanctuary during 1985, communal nesting occurred at only three locations, namely Baroli, Bharrah and Pureini (Fig. 1). Data for the present paper were collected from Baroli and Pureini.

Baroli is 57 km downstream from the Chambal-Parbati confluence. The nesting island is approx. 1 km in length and is about 7 m above the water line during the dry season. At least 85% of the island is covered by sand and xerophytic bushes. During summer when the river is low, the eastern bank of the island connects with the mainland. Female gharials use the western face of the island for nesting. Here the river is fast-flowing and over 10 m deep (Fig. 2).

Pureini is located 173 km downstream from Baroli. Human activities in the form of agriculture and fishing are relatively more than at Baroli. Nesting occurs on the northern bank which is open without any vegetation. The river is over 15 m deep during summer (Fig. 3).

Methods

During February-July 1985 regular inspections were made at Pureini and Baroli, particularly the latter, and information on the dates of nesting, sequences of nesting by different females, spatial distribution of nests at the nesting banks, nest-wise sequences of hatching, and post-hatching social organisation of hatchlings and adults were recorded.

During early morning inspections in February-April we looked for long, inverted U-shaped characteristic tracks of nesting females which led away from water. Where nesting had occurred, at the apex of the U-track, the sand was loose, moist and disturbed. After probing and locating a nest the following data were

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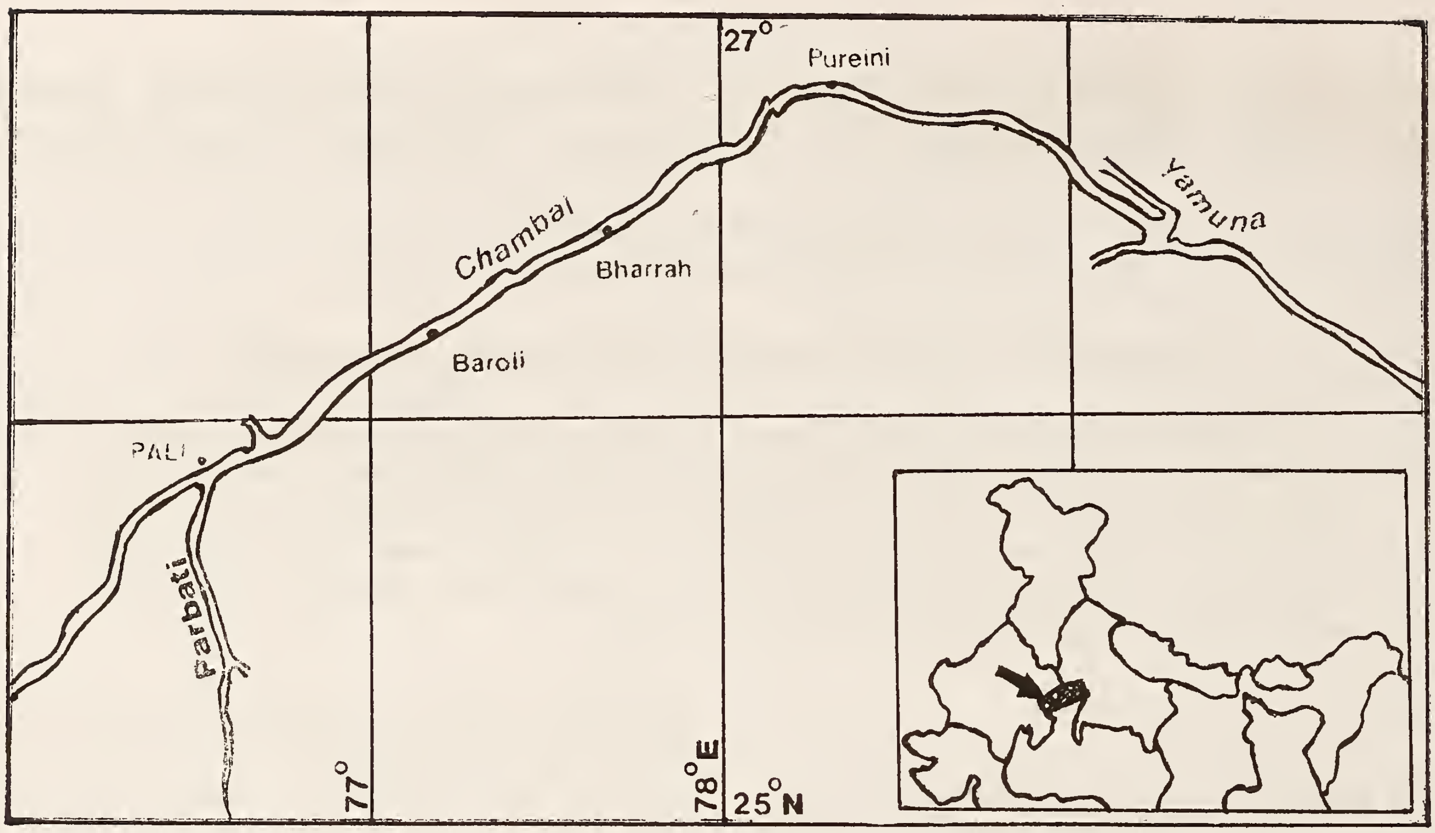
27°
Pureini
Yamuna
Chambal
Bharrah
Baroli
PALI
Parbati
77°
78°E
25°N

Fig. 1. Part of the National Chambal Sanctuary, showing locations of colonial nesting sites. Inset: Location on map of India.

recorded: precise location on a sketch of the nesting bank, distance from water, height above water, distance from and height above the nest laid prior to it, distance from the nest nearest to it, date of egg-laying, clutch size, and the chronological number in which the nest was laid during the season.

From the last week of May up to about the middle of July inspections were intensified to coincide with the season of hatching. Hatched-

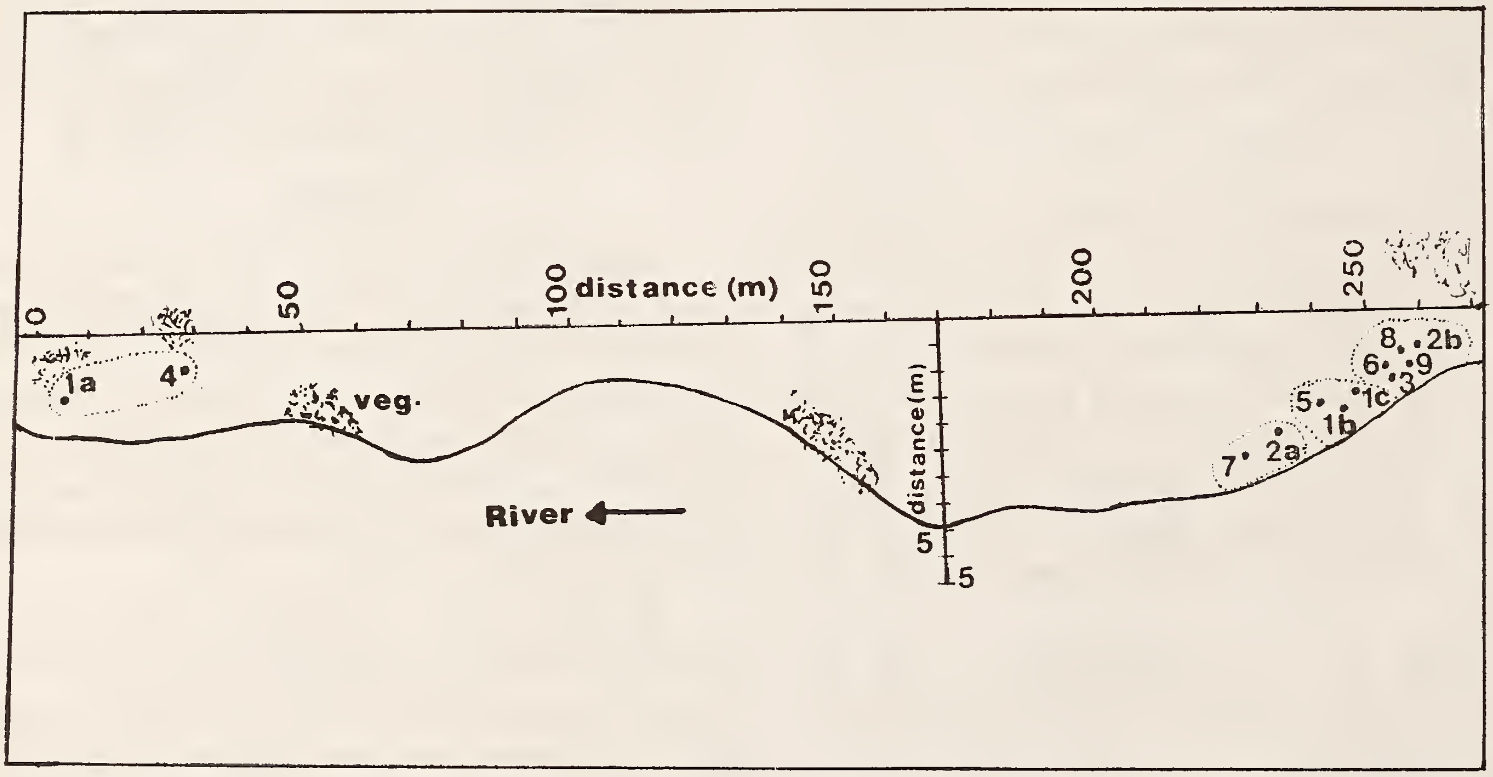
0
50
100
distance (m)
150
200
250
1a
4
veg.
River
distance (m)
5
5
8
2b
6
9
3
5
1c
1b
7
2a

Fig. 2. Nest distribution pattern at colonial nesting site at Baroli. The scales touching the river and sand bank indicate distances (not height) of the nests with respect to shoreline and other nests. Arrow shows direction of river flow. Serial numbers of nests as in Table 1. Veg. = vegetation.

out nests were usually noticed in the morning. These appeared as wide-mouthed craters with scattered empty egg shells leading to the river along the return track of the female. Data were recorded on the date of hatching, number of empty egg shells, number of unhatched eggs, and numbers of hatchlings (if) seen on the river bank and distinguishable as a separate creche probably belonging to the just-hatched nest.

During observations made after all the nests had hatched, we recorded the numbers of hatchling-creches, the number of females attending close by, and the locations of other females and males. Any other behaviour which we could relate to parental attendance to hatchlings, were also taken note of. The study was terminated by 15 July when the river was in flood (Fig. 4).

RESULTS

Pre-nesting activities: By 19 February gharial tracks were seen leading 8 m from water. Probably these were left by potential nesters because at other times of the year a gharial seldom goes beyond 2-3 m from the water's edge.

Small pits ('probe pits') about 15-20 cm deep and the same width were detected at the future nesting site after 9 March. 'Trial nests' were detected after 23 March. These were fully-dug, uncovered chambers without eggs and resembling an actual nest-pit in shape and size (Singh, L.A.K. 1978).

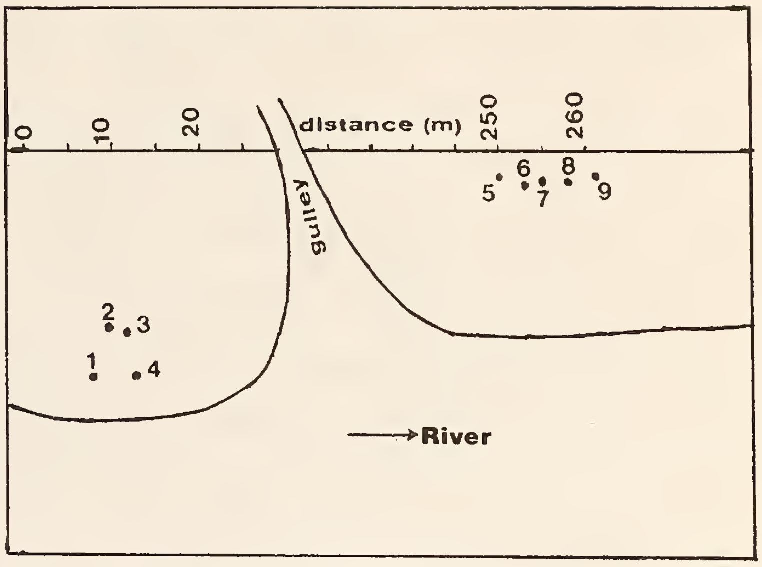

Fig. 3. Nest distribution pattern at colonial nesting site at Pureini. Numbering of nests indicates the sequence in which nests were found, not sequence of laying.

Nesting at Baroli: A total of 12 nests were laid between 26 March and 9 April, on a total of nine nesting-nights. On the first nesting night there were three nests, on the second there were two, and on seven other nights there was one

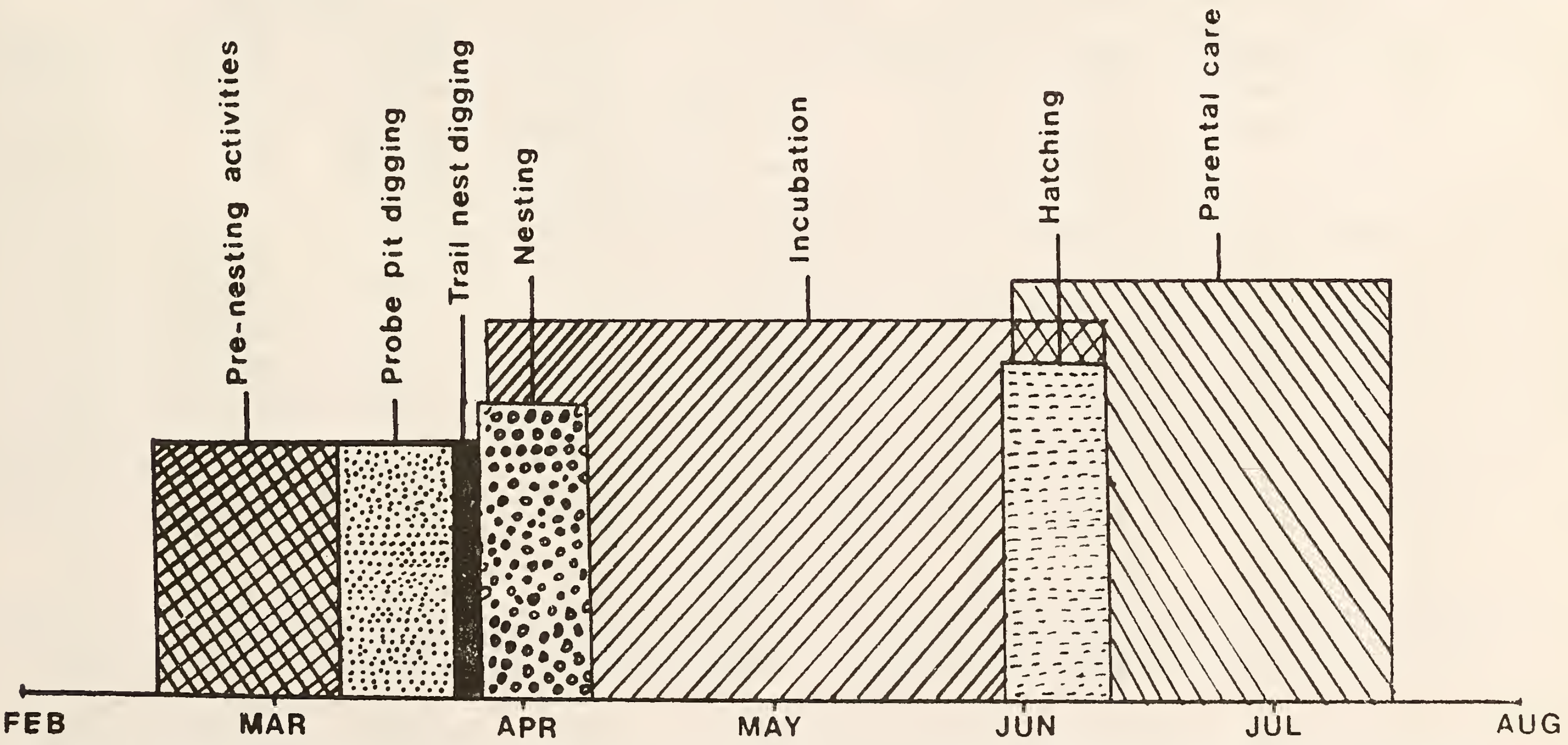

Fig. 4. Time of pre-nesting to post-hatching activities at Baroli during 1985. The heights of shaded areas differ only to demonstrate overlapping periods.

nest each. The spatial distribution of these nests is shown in Table 1 and Fig. 2. The mean distance between two adjacent nests was 6.1 ± 8.3 m. Regardless of when laid or how far apart the nests were made, any two adjacent nests occupied different heights above the water level, thereby reducing the chance of exhumation of an earlier-laid nest. The distance of a nest from the one laid immediately prior to it ranged from 1.2 m to 241.7 m. The nests were located 7.7 ± 1.8 m away and at 1.3 ± 0.2 m height above water level. The clutch size was 37 ± 11 eggs (range 17-50).

Four of the 12 nests were collected for the captive-rearing programme. The rest were left for incubation *in situ*.

Nesting at Pureini: There were a total of nine nests made between 29 March and 7 April. The minimum distance between two adjacent nests ranged from 1.2 m to 3.0 m. All nests were collected and shifted for captive management.

Hatching: All eight nests at Baroli hatched between 31 May and 11 June, i.e. 61-69 days (mean 64 ± 3 days) after nesting. Hatching success within a clutch was 65.7% to 100% (mean 91.2 ± 10.9%) excluding a clutch of 17 eggs in which none hatched. During the last week of May and first week of June, when hatching time was approaching, tracks from water to the nests were numerous. The number of such tracks gradually decreased as the hatching season progressed.

Hatchling attendance: After hatching, the juveniles usually remained in the water just below the nest from which they hatched. Within a day they joined the creche of hatchlings which hatched earlier at the communal nesting site. Thus larger creches were formed with the advancement of the hatching season.

Each creche of hatchlings was attended only by a single female. Therefore, when smaller creches joined to form larger creches the numbers of attending females decreased. By 11 June there was only one large creche attended by a single female. Earlier, when there were three smaller creches of hatchlings, it was observed that all three attending females were distinctly larger than those which kept to midstream islands.

The male gharial at the Baroli nesting site

TABLE 1

GHARIAL NEST DISTRIBUTION AT BAROLI COMMUNAL NESTING SITE DURING 1985

Nest No.	Clutch size	Distance from water	Height above water level (m)	Sl. number of the nearest nest	Distance from the nearest nest (m)	Distance from nest laid prior to it (m)	Height above nest laid prior to it (m)	Date of nesting	Incubation period (days)
la	17	6.5	1.0	4	23.5	—	—	26 Mar.	*
lb	43	5.5	1.1	lc	2.0	241.7	0.1	26 Mar.	**
lc	42	7.2	1.4	lb	2.0	2.0	0.3	26 Mar.	69
2a	49	8.0	1.3	7	6.0	14.2	– 0.1	28 Mar.	**
2b	31	8.8	1.5	12	0.8	26.2	0.2	28 Mar.	65
3	32	5.2	1.0	6	1.7	3.8	– 0.5	29 Mar.	66
4	54	11.5	1.2	la	23.5	228.4	0.2	30 Mar.	61
5	50	9.0	1.5	lb	4.0	214.2	0.3	1 Apr.	**
6	35	8.5	1.5	3	1.7	12.5	0.0	2 Apr.	65
7	50	7.5	0.9	2a	6.0	26.7	– 0.6	4 Apr.	64
8	24	9.0	1.5	12	1.2	30.2	0.6	9 Apr.	62
9	37	6.0	1.3	2b	0.8	1.2	– 0.2	11/12 Apr.	61
Mean	38	7.7	1.3	—	6.1	72.8	0.025	—	64
± SD	11	1.8	0.2	—	8.3	100.4	0.341	—	3

* Did not hatch. ** Collected for captive hatching programme.

normally basked within about 500 m downstream of the communal nesting site. Whenever an 'intruder' (human or bovine) approached the nesting site along the bank from downstream the male followed the 'intruder' from the water until it reached the hatchlings, where an attending female was invariably present. After emitting loud nasal hissing sounds, the male normally returned to its previous basking position.

Discussion

Communal nesting has been recorded in *Crocodylus johnstoni* (Webb 1981) and *C. niloticus* (Cott 1961); both species are 'hole nesters'. In *C. johnstoni* up to 18 nests have been found at a communal nesting ground within 50 m, while in *C. niloticus* Cott illustrated numerous craters each denoting a hatched-out nest, and mentioned the presence of 24 craters in an area of approx. 550 sq. m. Among the Indian crocodilians gharial and mugger (*palustris*) are 'hole nesters'. *C. palustris* is recorded to have three nests within a shore length of 20 m at Sathanur, Tamil Nadu, and eight nests in an area of 15 sq. m at the Hiran lake in Gir National Park (B.C. Choudhury, pers. comm. 1986). Singh (1991) observed four nesting females of *C. palustris* in an expansive breeding pen at Ramatirtha, Orissa for three consecutive seasons and concluded that the dominant female may share the same nesting site within 10 sq. m only with the females third and fourth in the hierarchial order.

Gharials are only mildly territorial. This is evident when the larger females non-aggressively (1) select a future nesting site first in the season, and (2) guard the large conglomerate creche of hatchlings. Such territoriality does not appear to impede in sharing the same nesting habitat. As observed at Baroli, 10 nests were in an area of approx. 60 sq. m, and at Pureini in one batch five nests were in an area of 44 sq. m, and another four nests were in an area of 300 sq. m. At Baroli, where observations were continued, the nests were so laid that upon hatching their 'craters' did not overlap beyond the rims. Nests made close together on the same night were spaced so that body contact between two nesting females could not have taken place. It is suspected that females which nested later were able to detect the location of a nest laid earlier and avoided digging into or close to it.

Therefore, communal nesting may be a species-based characteristic of gharial, and probably other less territorial 'hole-nesting' crocodilians. In gharial the average adult sex-ratio is 1 male: 3 females. The male may play a greater role in hatchling attendance than we know. Communal nesting may improve hatchling survival because there are larger numbers of females in attendance, and that a larger creche of hatchlings may ensure better social communication aimed at better survival rate. In recent years, with increased pressure on habitats due to man-made causes, communal nesting may be a useful adaptation to overcome the shortage of secure nesting grounds.

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REVISION OF GENUS *FERNA* MALAISE (HYMENOPTERA : TENTHREDINIDAE : ALLANTINAE) FROM INDIA[1]

Malkiat S. Saini and Jagdeep S. Deep[2]

(With twenty text-figures)

Key words: *Ferna bengalensis, F. punctifossa, F. longiserra, F. brevigenata.*

The genus *Ferna* Malaise in India has been revised. To the previously recorded single species, another is added while two others, *F. punctifossa* and *F. longiserra*, represent first records. A new species, *F. bengalensis*, is described and illustrated. A workable dichotomous key for the known species is given.

Introduction

The genus *Ferna* described by Malaise in 1961 is so far represented by six species. Prior to 1983, when Muche reported *F. brevigenata* from Darjeeling (India), it was confined to Burma. In this report *F. punctifossa* and *F. longiserra* represent first records from India and *F. bengalensis* is new to science. For confirmation and comparison the concerned types of *Ferna* were procured on loan from N.R. Stockholm. This genus is characterised by the body being pale yellow below and black above and black with rich pale markings and yellow with black ones. Mandibles sub-symmetric, each with more or less blunt subapical tooth. Anal cell cross vein meets brachium at 60°-40° and hind wings have one closed middle cell.

Abbreviations used: EL – eye length, LID – lower interocular distance, IDMO – interocular distance at level of median ocellus, OOL – oculo-ocellar line, OCL – ocello-occipital line, POL – postocellar line, IATS – inner apical tibial spur, OATS – outer apical tibial spur, MB – metabasitarsus, ICD – inter cenchri distance, ITD – inter tarsal distance.

KEY TO THE INDIAN SPECIES OF *Ferna* MALAISE

1. Mesoscutellum with a faint longitudinal carina in posterior half; median fovea in form of a long depression touching median ocellus, deeper in anterior half .... *Ferna brevigenata* Malaise, 1961

— Mesoscutellum not carinated; median fovea not reaching median ocellus. 2

2. Circum-, inter-, postocellar and lateral furrows indistinct; median fovea in form of a shallow depression .... *Ferna bengalensis* sp. nov.

— Circum-, interocellar and lateral furrows distinct; median fovea in form of a deep ditch 3

3. Postocellar furrow indistinct; lateral furrows triangularly widened into a punctiform pit just behind each lateral ocellus; metabasitarsus and following joints combined in ratio 5 : 6 .... *Ferna punctifossa* Malaise, 1961

— Postocellar furrow distinct; lateral furrows deep, sunken, excurved, not reaching hind margin of head; metabasitarsus and following joints combined in ratio 5 : 7 .... *Ferna longiserra* Malaise, 1961

Ferna brevigenata Malaise, 1961
(Figs. 2, 4, 11, 17)

Ferna brevigenata Malaise, 1961. Ent. Tidskr. Arg. 82, Hafte 3-4, p. 258.

FEMALE: Average length 6.5 mm. Body black. Clypeus, labrum, mandible barring apex, supraclypeal area, broad stripe along inner orbit, malar space, broad stripe along hind orbit reaching temple, anterolateral, posterior and posterodorsal margin of pronotum; tegula; spot on anterior slope of mesoscutellum, spot on mesepisternum, metepisternum, meso- and metasterna; all legs; narrow posterior margin of terga 2-7 and deflexed part of terga; all sterna; are pale yellow. Wings hyaline, costa and stigma fulvous, venation brown.

Antenna 9-segmented, 2.9 x head width,

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scape and pedicel longer than broad, segments 3 and 4 in ratio 6:7, segments 6-9 subequal in length. Clypeus (Fig. 4) roundly to subsquarely incised up to half of its medial length with broad rounded lateral teeth; labrum broader than long in ratio 3:2 with deflexed rounded anterior margin; malar space 1.1 x diameter of median ocellus; lower margin of eye slightly below level of antennal socket; LID:IDMO:EL = 2.0:2.2:1.2; head without postgenal carina; supraclypeal and supra-antennal pits well marked; frontal area elevated much above level of eyes; antennal furrows shallow, distinct in anterior half only; median fovea in form of a long depression, deeper in anterior half; circum-, inter- and postocellar furrows distinct; lateral furrows deep, falling short of hind margin of head; postocellar area broader than long in ratio 7 : 4; head slightly narrowing behind eyes, OOL:POL:OCL = 2.0:1.0:1.8; mesoscutellum hardly elevated with a faint indication of a longitudinal carina in posterior half; appendage not carinate; ICD:ITD = 1.0:4.0; mesepisternum roundly raised without carina or acute apex; tarsal claw (Fig. 2) with a long apical and slightly shorter subapical teeth, basal lobe absent; metabasitarsus shorter than following tarsal joints combined in ratio 4:5; IATS:MB:OATS = 2.0:5.0:1.7.

Head and mesonotum minutely and densely punctured; mesoscutellum punctured like head on anterior slope, with large pictures on posterior slope; appendage impunctate; mesopleuron, sternum and abdomen shining with minute scattered punctures.

Lancet (Fig. 17) having about 15 serrulae. Each serrula is shallow with 9-10 anterior and 4-5 posterior sub-basal teeth. Hypopygium as in Fig. 11.

MALE: Not found.

Population variation: Not observed.

Holotype depository: Female, NR, Stockholm.

Paratypes: four females, seven males, NR, Stockholm.

Specimens examined: 9 females, Himachal Pradesh: Dalhousie, Kalatop – 2880 m, 29 June to 1 July 1986.

Distribution: Burma. INDIA: West Bengal, Himachal Pradesh.

The specimens examined agree with Malaise's (1961) key for species of *Ferna* and resemble well the original description. This species is characterised by mesoscutellum with a faint longitudinal carina in the posterior half and median fovea touching median ocellus in the form of a long depression. The species was originally described by Malaise from Burma but later on Muche (1983) reported it from Darjeeling.

Ferna bengalensis sp. nov.

(Figs. 1, 3, 10, 18)

FEMALE: Average length 6.5 mm. Body black. Clypeus; labrum; mandible barring apex; supraclypeal area up to supra-antennal tubercle; malar space; broad stripe along inner orbit; hind orbit continuing as a stripe on temple; narrow margin of pronotum; tegula; spot on anterior slope of mesoscutellum; lower half of mesepisternum except broad anterodorsal angle; mesosternum; all legs (tarsi infumated towards tip); all sterna, deflexed parts of terga; tergum 9; are yellowish white. Wings hyaline, costa and stigma fulvous, venation dark brown.

Antenna 9-segmented, 2.8 x head width, scape and pedicel longer than broad, segment 3 indistinctly shorter than 4, segments 6-9 subequal in length; clypeus (Fig. 3) roundly narrowly incised up to one-third of its medial length with broad and rounded lateral teeth; labrum broader than long in ratio 5:3 with deflexed rounded anterior margin; malar space 1 x diameter of median ocellus; lower margin of eye below level of antennal socket; LID:IDMO:EL = 2.0:2.0:1.0; head without postgenal carina; supraclypeal and supra-antennal pits well marked; frontal area roundly elevated above level of eyes; antennal furrows well marked; median fovea in form of a shallow depression. Circum-, inter- and postocellar furrows indistinct; lateral furrows not well marked; postocellar area almost flat, broader than long in ratio 3:2; head slightly narrowing behind eyes; OOL:POL:OCL = 2.0:1.0:1.7; mesoscutellum slightly elevated; appendage not carinate; ICD:ITD = 1.0:4.0; mesepisternum roundly raised without carina or acute apex; tarsal claw (Fig. 1) with a long apical and short subapical teeth, basal lobe absent; metabasitarsus shorter than following tarsal joints combined in ratio 5:6; IATS:MB:OATS = 1.8:5.0:1.5.

Head, mesonotum and mesoscutellum minutely punctured (interocellar area with distinct punctures); appendage polished; mesepisternum and sternum shining with indistinct scattered punctures; abdomen impunctate.

Lancet (Fig. 18) having 14-15 serrulae. Each serrula is triangular with 7 anterior and 3-4 posterior sub-basal teeth.

Hypopygium as in Fig. 10.

MALE: Not found.

Population variation: Single specimen examined.

Holotype: Female, West Bengal, Darjeeling, 2800 m, 2 May 1986.

Paratype: Nil.

Distribution: INDIA: West Bengal.

The species can be distinguished from *F. punctifossa* keyed out at couplet 2 (Malaise 1961) in having lateral furrows indistinct (distinct in *F. punctifossa*), postocellar area broader than long in ratio 3:2 (little broader than long in *F. punctifossa*) and median fovea in the form of a continuous shallow depression (almost flat before median ocellus in *F. punctifossa*). The species is characterised by having circum-, inter- and postocellar furrows indistinct.

Etymology: The species has been named after the state in which its type locality is situated.

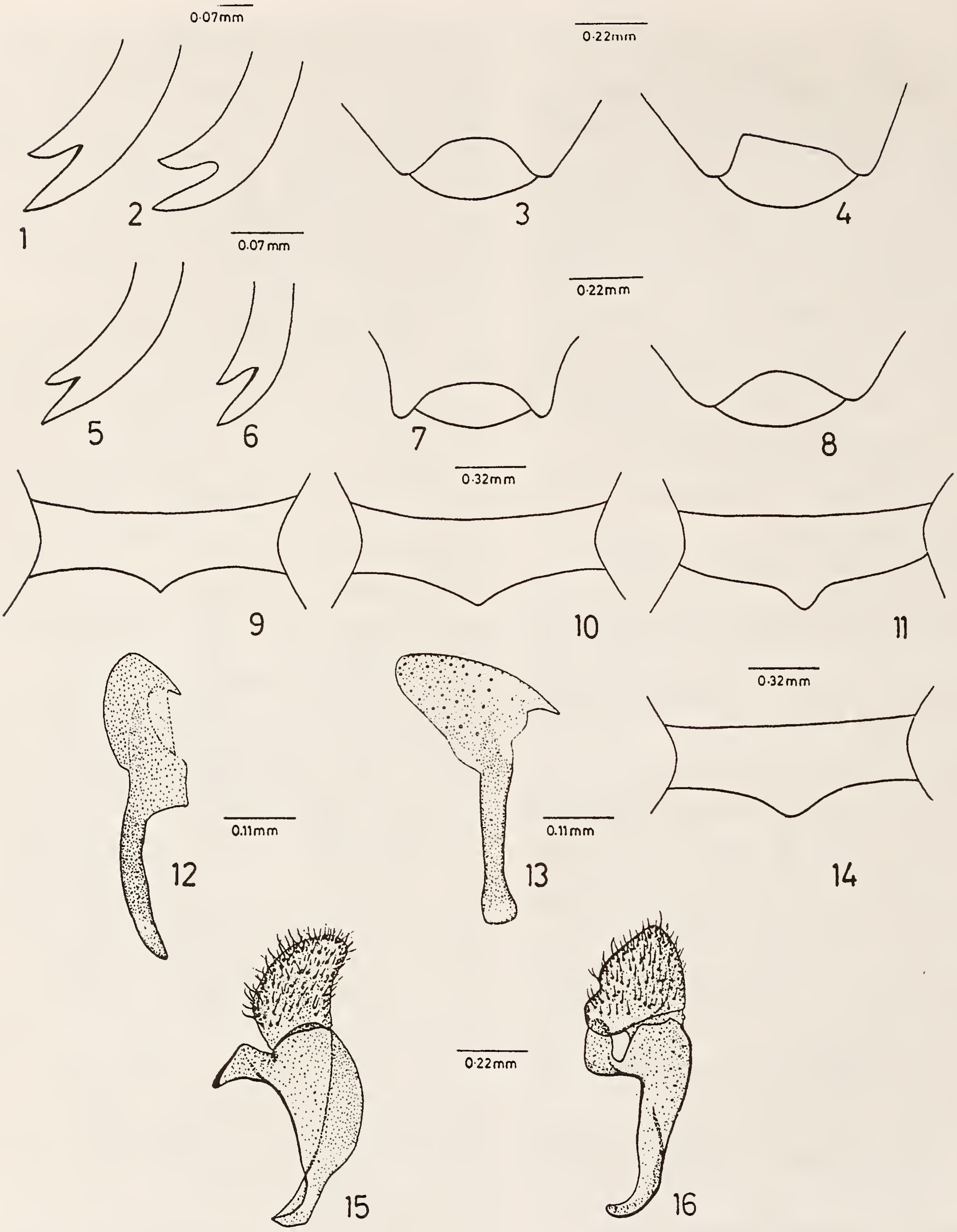
Ferna punctifossa Malaise, 1961
(Figs. 6, 8, 9, 13, 16, 19)

Ferna punctifossa Malaise, 1961, Ent. Tidshr. Arg. 82, Hafte 3-4, p. 259.

FEMALE: Average length 5.5 mm. Body black. Clypeus; labrum; mandible barring apex; supraclypeal area; broad stripe along inner orbit; malar space; hind orbit continuing as transverse spot up to temple; tegula; broad medial spot on anterior slope of mesoscutellum; spot on mesepisternum continuing with entirely yellow mesosternum; all legs, deflexed sides of all terga; tergum 9; sterna entirely; are yellowish. Wings hyaline, costa and stigma fulvous, venation brown.

Antenna 9-segmented, 3.0 x head width, scape and pedicel longer than broad, segments 3 and 4 in ratio 6:7, segments 7-9 subequal in length; clypeus (Fig. 8) roundly incised up to two-fifths of its medial length with broad, rounded lateral teeth; labrum broader than long in ratio 5 : 3 with deflexed rounded anterior margin; malar space 1 x diameter of median ocellus; lower margin of eye below level of antennal socket; LID:IDMO:EL = 2.0:2.1:1.0; head without postgenal carina; supraclypeal and supra-antennal pits well marked; frontal area roundly elevated above level of eyes; antennal furrows well marked; median fovea in form of a deep ditch in anterior half only; circumocellar furrow distinct; interocellar furrow broad and deep; postocellar furrow indistinct; lateral furrows triangularly widened into a punctiform pit just behind each lateral ocellus, not reaching hind margin of head; postocellar area slightly elevated, broader than long in ratio 6:5; head slightly narrowing behind eyes; OOL:POL:OCL = 2.2:1.0:2.0; mesoscutellum somewhat roundly elevated; appendage not carinate; ICD:ITD = 1.0:4.0; mesepisternum roundly raised without carina or acute apex; tarsal claw (Fig. 6) with long apical and short subapical teeth, basal lobe absent; metabasitarsus shorter than following tarsal joints combined in ratio 5:6; IATS:MB:OATS = 2.0:5.0:1.7.

Head minutely and densely punctured; mesonotum subshining with minute scattered punctures; mesoscutellum punctured like head; appendage impunctate; mesopleuron and mesosternum shining with minute punctures; abdomen impunctate.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Figs. 1-16. Species of the genus *Ferna* Malaise
1. Tarsal claw of *bengalensis*; 2. Tarsal claw of *brevigenata*; 3. Clypeus and labrum of *bengalensis*; 4. Clypeus and labrum of *brevigenata*; 5. Tarsal claw of *longiserra*; 6. Tarsal claw of *punctifossa*; 7. Clypeus and labrum of *longiserra*; 8. Clypeus and labrum of *punctifossa*; 9. Hypopygium of *punctifossa*; 10. Hypopygium of *bengalensis*; 11. Hypopygium of *brevigenata*; 12. Penis valve of *longiserra*; 13. Penis valve of *punctifossa*; 14. Hypopygium of *longiserra*; 15. Gonoforceps of *longiserra*; 16. Gonoforceps of *punctifossa*.

Lancet (Fig. 19) having about 16 serrulae. Each serrula is shallow with seven anterior and 2-3 posterior sub-basal teeth.

Hypopygium as in Fig. 9.

MALE: Average length 5.0 mm. Similar to female.

Male genitalia: Penis valve as in Fig. 13, gonoforceps as in Fig. 16.

Population variation: Fulvous colour is pale yellow in the population.

Holotype depository: Female, NR, Stockholm.

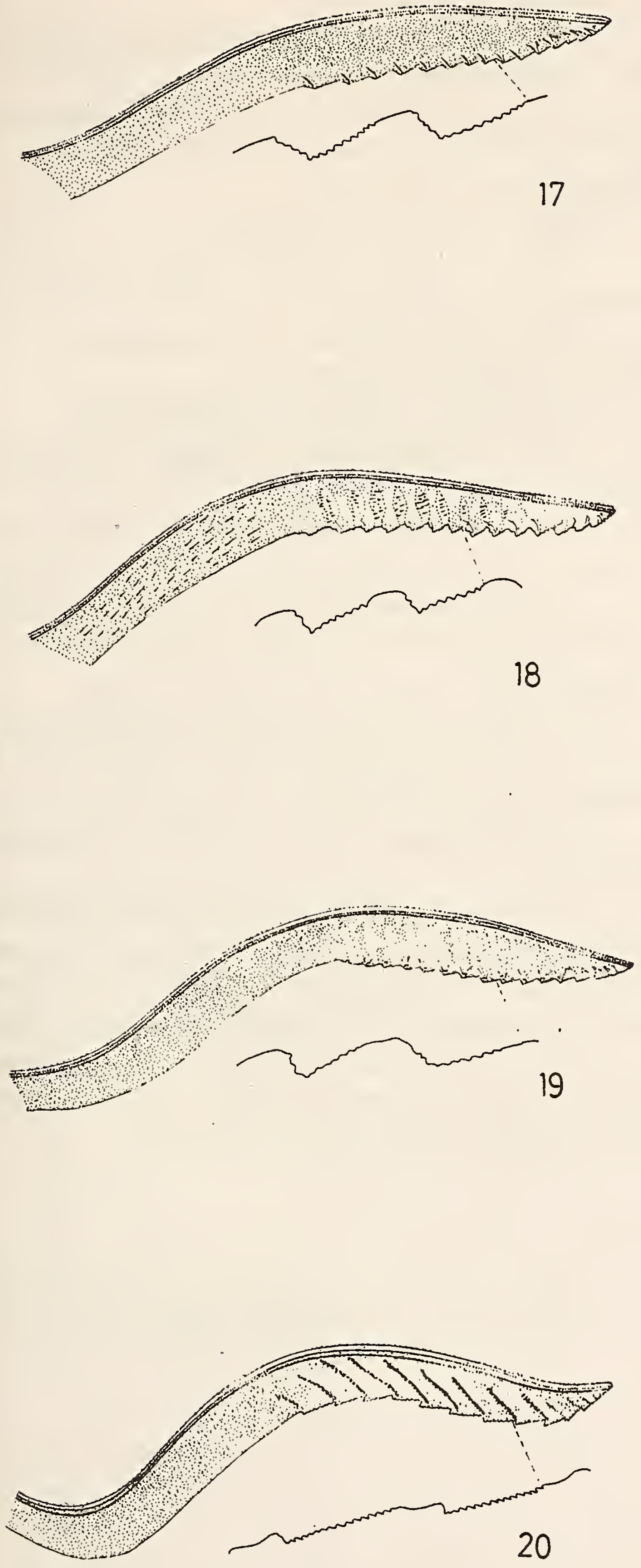
Paratypes: four females, two males, NR, Stockholm

Specimens examined: 6 females, 20 males, West Bengal: Darjeeling, 2880 m, 2 May to 4 May 1986. 4 males, Arunachal Pradesh : Bomdila, 2800 m, 1 June to 2 June 1989. 13 females, 9 males, Himachal Pradesh : Dalhousie, Kalatop, 2800 m, 28 June to 2 July 1986.

Paratype (female) bearing slips, "Kambatti 2135 m, N.E. Burma, 9/6, R. Malaise, 24/90".

Distribution: Burma. INDIA: West Bengal, Arunachal Pradesh and Himachal Pradesh.

The specimens agree with Malaise's (1961) key for *Ferna* and comply well with the original description and the paratypes received on loan from NR, Stockholm. The species is characterised by the lateral furrows widened triangularly into punctiform pits just behind lateral ocellus. This is a first report of the species from India.



Figs. 17-20. Species of the genus *Ferna* Malaise
17. Lancet of *brevigenata;* 18. Lancet of *bengalensis;*
19. Lancet of *punctifossa;* 20. Lancet of *longiserra.*

Ferna longiserra Malaise, 1961
(Figs. 5, 7, 12, 14, 15, 20)

Ferna longiserra Malaise, 1961. Ent. Tidskr. Arg. 82, Hafte 3-4, p. 260.

FEMALE: Average length 6.0 mm. Body black. Clypeus; labrum; mandible barring apex; supraclypeal area; spot on supra-antennal tubercles; malar space, continuing as a stripe along inner orbits; narrow transverse spot on temple; narrow margin of pronotum; tegula; broad transverse spot on mesepisternum along its border with sternum; all legs (tarsi somewhat fulvous); very narrow hind margin of terga, deflexed sides of terga and all sterna; are cadmium yellow. Wings smoky hyaline; costa, stigma and venation black.

Antenna 9-segmented, 2.7 x head width, scape and pedicel longer than broad, scape distinctly so, segments 3-4 subequal, segments 6-8 subequal in length, 9th slightly shorter, clypeus (Fig. 7) roundly incised up to half of its medial length with broad, lateral teeth; labrum broader than long in ratio 5:3 with deflexed, rounded anterior margin; malar space 1 x diameter of median ocellus; lower margin of eye just below level of antennal socket; LID:IDMO:EL = 2.0:2.1:1.4; head without postgenal carina; supraclypeal and supra-antennal pits well marked; frontal area roundly elevated above level of eyes; antennal furrows deep, well marked; median fovea in form of a deep ditch not reaching median ocellus; circum-, inter- and postocellar furrows sharp, lateral furrows deep, sunken, excurved, not reaching hind margin of head; postocellar area slightly elevated, broader than long in ratio 2:1.1; head narrowing behind eyes; OOL:POL:OCL = 1.8:1.0:1.2; mesoscutellum flat; appendage not carinate; ICD:ITD = 1.0:4.0; mesepisternum roundly raised without carina or acute apex; tarsal claw (Fig. 5) with a long apical and short subapical teeth, basal lobe absent; metabasitarsus shorter than following tarsal joints combined in ratio 5 : 7; IAITS : MB : OATS = 2.0 : 5.0 : 1.5.

Head and thorax shining with few scattered punctures; abdomen impunctate.

Lancet (Fig. 20) having about 12 serrulae, each serrula with innumerable anterior and no posterior sub-basal teeth.

Hypopygium as in Fig. 14.

MALE: Average length 5.5 mm. Similar to female.

Male genitalia: Penis valve as in Fig. 12, gonoforceps as in Fig. 15.

Population variation: Not observed.

Holotype depository: Female, NR, Stockholm

Paratypes: 29 females, 6 males, NR, Stockholm.

Specimens examined: 4 females, 1 male, Arunachal Pradesh: Bomdila 2800 m 30 May to 1 June 1989.

Paratypes (female, male) bearing slips, "N.E. Burma, Kambatti 2135 m, 16/6 & 2/6 R. Malaise 22/90 & 23/190".

Distribution: Burma; INDIA: Arunachal Pradesh.

The specimens fit in Malaise's 1961 key for *Ferna* and comply well with the original description (in key) and paratypes (gift from NR, Stockholm). This species is characterised by the sawsheath being very long, and the lateral furrows, deep, sunken, excurved and not reaching hypothetical hind margin of head.

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OBSERVATIONS ON THE SHEDDING OF GILL-RAKER PROCESSES IN THE GOLDSPOTTED MULLET *LIZA PARSIA* (HAMILTON-BUCHANAN, 1822) (PISCES : MUGILIDAE)[1]

S.K. Barve[2] and D.R. Jalihal[3]

(With twenty text-figures)

Key words: gill-raker processes, *Liza parsia*, mullet.

The phenomenon of shedding of gill-raker processes into water and later picking them up has been described in *Liza parsia*. The processes of an entire arch are shed as a single unit and it is possible to assign them to their respective rakers based on size ratio. Maximum shedding and subsequent engulfing was encountered during monsoon when there is marked increase in the turbidity of estuarine waters. However, it is not yet known whether these processes really form the food of mullets.

Introduction

An interesting observation about the occurrence of a large amount of peculiar structures closely resembling polychaete worms in the gut contents has been reported by several workers while studying the food and feeding habits of grey mullets (Chidambaram and Kuriyan 1952, Pillay 1953, Sarojini 1954). Tung (1970) called them "branchial filaments of unknown origin". However, Luther (1962), based on his studies on *Mugil cephalus* and *Liza macrolepis*, was the first to conclusively state that these structures are nothing but gill-raker processes of the mullets. His subsequent studies (Luther 1965) revealed that : (1) The mullets shed their gill-raker processes into the water and later pick them up at the time of feeding. (2) They do not swallow their own processes. (3) Only the third, fourth and fifth (ceratobranchial) arches shed their processes.

According to Natarajan and Reddy (1976), processes on all arches except the first are shed in the above two species. The present work was undertaken to ascertain the position in another species, the goldspotted mullet *Liza parsia* (Hamilton-Buchanan, 1822), which is the most commonly available mugilid in the Ratnagiri region (west coast of Maharashtra state).

Material and Methods

A number of specimens freshly obtained from Ratnagiri fish market were examined for the presence of gill-raker processes both on branchial apparatus as well as in gut contents. When present, the processes form a dense greyish mass on the rakers which can be readily recognised. Each gill arch has an outer and an inner row of bristle-like rakers which are generally sheathed by processes. The processes encountered in stomach contents were also examined to find out their possible relationship with those found on branchial apparatus.

Results and Discussion

It was observed that several specimens with intact processes on branchial apparatus also had them in their stomach contents, thereby proving that mullets do not swallow their own processes. As also mentioned by Luther (1965), the processes in the gut were mostly associated with benthic copepods, foraminiferans and diatoms, thus indicating that they are first shed into water and later on picked up along with the food. This has been experimentally substantiated by Natarajan and Reddy (1976) who successfully induced *Mugil cephalus* and *Liza macrolepis*

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TABLE 1
LENGTH RATIOS OF RAKERS AND PROCESSES IN *Liza parsia*

Gill arch number	Ratio of length of rakers (inner row: outer row)	Ratio of length of processes (inner row: outer row)
First	0.49 to 0.57 (average 0.52)	Processes absent
Second	0.53 to 0.69 (average 0.60)	0.55 to 0.62 (average 0.59)
Third	0.60 to 0.74 (average 0.66)	0.60 to 0.67 (average 0.64)
Fourth	0.78 to 1.00 (average 0.91)	0.86 to 0.96 (average 0.92)

to shed their processes by mixing charcoal in tanks containing filtered water. During the present investigation, the processes were not encountered on rakers of the first gill arch. On the other hand, rakers of all the remaining three arches, in addition to those of ceratobranchial, were generally found ensheathed with processes. Thus, it is evident that all rakers, except on the first gill arch, shed their processes.

The ratios of lengths of rakers on inner as well as outer rows with their corresponding processes are shown in Table 1. It is seen that the ratios of raker lengths are very similar to the ratios of process lengths and, therefore, by measuring the processes found in the gut, it is possible to predict their corresponding arches.

In the first arch (Fig. 1), gill-rakers of the inner row are distinctly shorter, being only about half of the outer row (Fig. 2). The rakers on inner row of second and third arches (Figs. 3, 5) are about half to two-thirds (Fig. 4) and two-thirds to three-fourths (Fig. 6) the lengths of rakers on outer row respectively. In the fourth arch (Fig. 7), rakers of both rows are almost equal in size (Fig. 8). The rakers of ceratobranchial (Fig. 9), on the other hand, are modified to form inferior pharyngeal in the form of a concave floor.

In the first arch, the rakers on the outer row are spinulose only in the proximal half, while the terminal ends of both rows of gill rakers are normal and not joined together (Fig. 2). However, all rakers on the remaining arches are completely spinulose and provided with hood-like tips which adhere to one another, providing a measure of rigidity to the gills (Figs. 4, 6, 8, 10).

The strips of processes covering the rakers of the inner and outer rows (Fig. 11) are joined together along the median groove of the gill arch (Figs. 12-19). Laterally each strip has a secondary row of spines which in turn are provided with tertiary spinules (Fig. 20), leading to the formation of a complex sieving apparatus. The chances of this sieving apparatus getting clogged are higher during the monsoon owing to the high ingress of rain water and the resultant increase in the turbidity of estuarine waters. Therefore, the largest number of mullets with stomach contents dominated by gill-raker processes are encountered during the monsoon.

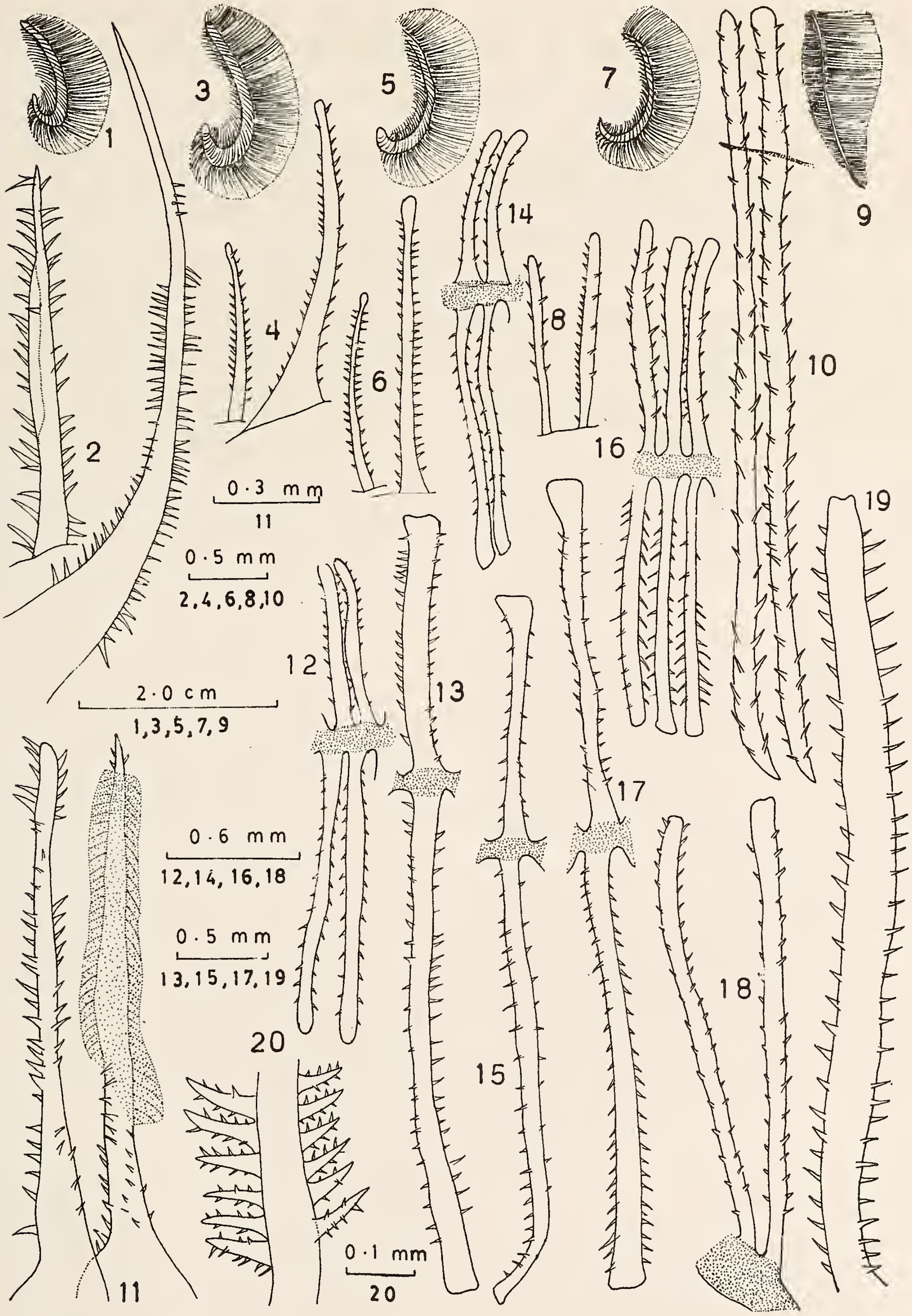
It was also observed that usually the processes of an entire arch are shed as a single unit. This may perhaps be due to the fact that the adhesive fleshy terminal hoods do not help in getting rid of the clogging effect.

In all probability, what Chidambaram and Kuriyan (1952), Pillay (1953) and Sarojini (1954) identified as ‘Polychaete moults’ or ‘Polychaete remains’ are apparently only gill-raker processes. The description of these structures as given by Sarojini (1954), viz. “These have the appearance of moults and consist of the entire outer skin with setae”, is in complete agreement with the features of gill-raker processes.

The shedding of gill-raker processes is a rather unique characteristic of mullets; such a feature has hitherto not been reported in any other group of fishes. It would, therefore, be interesting to study the regeneration of these processes, the food consumed before and after the shedding in addition to finding out whether the processes really form the food of mullets.

ACKNOWLEDGEMENTS

We express our gratitude to Dr K.N.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1,3,5,7,9
0·6 mm
12,14,16,18
0·5 mm
13,15,17,19
0·1 mm
20

Figs. 1-20. Gill-raker processes in *Liza parsia* (Hamilton-Buchanan)

1. First gill; 2. Inner and outer gill-rakers of first gill; 3. Second gill; 4. Inner and outer gill-rakers of second gill; 5. Third gill; 6. Inner and outer gill-rakers of third gill; 7. Fourth gill; 8. Inner and outer gill-rakers of fourth gill; 9. Ceratobranchial (fifth gill); 10. Gill-rakers of ceratobranchial; 11. A plain gill-raker and another partly covered with a strip of process, 12. Strips of processes of second gill-raker; 13. Strips of inner and outer rakers of second gill; 14. Strips of processes of third gill-raker; 15. Strip of inner and outer rakers of third gill; 16. Strips of processes of fourth gill-raker; 17. Strip of inner and outer rakers of fourth gill; 18. Strips of processes of ceratobranchial; 19. Strip of process of a ceratobranchial; 20. Magnified view of a strip of processes showing secondary and tertiary spinules.

Sankolli, Associate Dean (Fisheries Faculty), for his constant encouragement and to the authorities of the Konkan Krishi Vidyapeeth for providing necessary facilities.

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SEED DISPERSAL BY MAMMALS AT POINT CALIMERE WILDLIFE SANCTUARY, TAMIL NADU[1]

P. BALASUBRAMANIAN[2] AND P.V. BOLE[3]

Key words: bonnet macaque, chital, civet, frugivory, jackal, mammal-fruits, *Prosopis chilensis*, seed dispersal, shortnosed fruit bat.

Plant-animal interactions are described with special reference to frugivory and seed dispersal by mammals at Pt. Calimere Wildlife Sanctuary, Tamil Nadu. Faeces of bonnet macaque, small Indian civet, jackal, spotted deer, seeds and chewed-off remains of fruits dropped by shortnosed fruit bat were collected and the seeds and fruits found were recorded. 39 plant species were dispersed by bonnet macaque; 23 by civet; 22 by jackal; 36 by fruit bat and 12 by spotted deer. 10 plant species were identified as being dispersed by mammals only. A new bat-plant is reported. Obligate inter-relations between some plants and mammals are recorded. Successful germination of seeds from mammalian faeces was observed. The importance of the exotic *Prosopis chilensis* in the community is recognised. Characteristics and morphological syndromes of mammal-fruits are described.

INTRODUCTION

The mechanics of seed dispersal have been observed and recorded for many centuries. However, seed dispersal as a central feature in the evolution of reproductive strategy and community interactions has only recently received attention. Much of the early information on seed dispersal was anecdotal (see Ridley 1936), but systematic observations have recently been reported on birds (Snow 1971, Morton 1973) and other animals (Smythe 1970, Howe 1980). Plant dispersal syndromes are described by Janzen (1969), Van der Pijl (1982) and Howe and Westley (1986).

Many tropical plants produce fleshy fruits and rely upon animals to disperse their seeds (Frankie *et al.* 1974, Croat 1975, Opler *et al.* 1980). Numerous tropical bird and mammal species consume these fruits and provide dispersal services (Snow 1981). Though much work on the dispersal ecology has been done in various tropical regions, systematic information is not available from the Indian subcontinent. However, some information is available on the utilization of fruits of various plant species by birds (Ali 1931, Ali and Ripley 1983, Johnson 1982) and mammals (Schaller 1967, Kuruvilla 1980, Johnsingh 1981, Sampath 1986, Dinerstein and Wemmer 1988) from this region. Hence, a study was conducted to record the vertebrate frugivores and their role in the dispersal of plants in the tropical dry evergreen forest biotope in Pt. Calimere Wildlife Sanctuary (see Balasubramanian 1990a). The data presented here provides information on the fruits and seeds of woody plants and climbers eaten and dispersed by mammals, and their interactions with these mammals.

STUDY AREA

Pt. Calimere (10°18′ N, 79°51′ E) is located on the Coromandel coast in Nagapattinam district, Tamil Nadu. It is bounded by the Bay of Bengal on the east and Palk Strait on the south. The sanctuary is constituted by an area of *c.* 25 sq. km with patches of forest separated from each other by broad, shallow tidal inlets of varying lengths. The soil is largely sandy with alluvial deposits. The average yearly maximum temperature recorded for four years (1980-1984) was 33.3°C, and minimum was 26.1°C (Hussain

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et al. 1984). The annual rainfall ranges from 1000-1500 mm with dissymmetric regime of rainfall (Meher-Homji 1984).

The vegetation of the sanctuary is classified as Tropical dry evergreen forest (Champion and Seth 1968). Hussain *et al.* (1984) reported 300 plant species from this sanctuary. The vegetation in general is stunted with 60% evergreen plants, and the rest annuals and dry deciduous species. Arborescent vegetation contributes about 17% of the species and is represented by species such as *Manilkara hexandra, Salvadora persica* and *Cassia fistula*. Shrubs and climbers form about 30% of vegetation. *Flacourtia indica, Toddalia asiatica* and *Securinega leucopyrus* are some of the commonly occurring shrubs; *Coccinia grandis* and *Tinospora cordifolia* are some of the common climbers. The introduced plant, *Prosopis chilensis* (Molina) Stuntz (= *P. juliflora*) is commonly found in the open grazing lands.

The shortnosed fruit bat *Cynopterus sphinx* and bonnet macaque *Macaca radiata* are the major fruit-eating mammals. The bonnet macaque and spotted deer *Axis axis* are introduced animals. Jackal *Canis aureus*, small Indian civet *Viverricula indica*, wild boar *Sus scrofa*, common mongoose *Herpestes edwardsii*, threestriped palm squirrel *Funambulus palmarum* and blacknaped hare *Lepus nigricollis* are the other mammals found in the sanctuary. The blackbuck *Antilope cervicapra* and Indian gerbille *Tatera indica* are common in the open grazing lands.

Sugathan (1982) reported 137 passerine bird species from this forest. The major frugivorous birds are bulbuls, mynas and koel.

METHODS

Definitions: *Frugivore:* Animals which eat fruit. *Dispersal:* Departure of seed from the parent plant. *Dispersal agent:* An animal that moves viable seeds from one location to another. *Legitimate seed dispersers:* Animals which ingest the whole fruit and either regurgitate or defecate the seeds intact. *Seed predators:* Animals which eat a seed fully or partly, usually killing the embryo.

Syndrome: Constellations of fruit attributes associated with particular categories of dispersal agents are called 'dispersal syndromes' (Ridley 1936, Van der Pijl 1982).

Collection and analysis of faecal material: The faeces of bonnet macaque, civet and jackal, pellets of spotted deer and droppings (seeds spat out after the pulp is chewed) of shortnosed fruit bat were collected twice a week. The samples were analysed, and the fruits and seeds found in them were recorded. Collections were regularly done for a period of 24 months. A minimum of 20 samples were collected for each animal per month. However, in the case of civet, due to the non-availability of sufficient faeces, only an average of five samples could be collected. One sample of faecal material for the bonnet macaque is one dung; for jackal and civet it is one scat; and for spotted deer one pellet group. Some roosts of fruit bat were identified. Seeds and fruit remains found under a specified roost during every collection trip were considered as one sample.

In addition to this, a total of 710 hours of observations were made on 61 plant species with fleshy fruits to record the birds and other animals visiting them to feed on the fruits (Balasubramanian 1990). These direct field observations helped to ascertain the feeding habits, especially fruit handling by various mammals, and are described here.

Blackbuck and blacknaped hare were mostly observed feeding on grasses and sedges. A preliminary analysis of their pellets revealed the absence of seeds of any woody plants. Data on the threestriped palm squirrel and Indian gerbille were also solely based on direct field observations. Due to the practical difficulties in the collection of mongoose faeces, only direct feeding observations are discussed. As the observations on wild boar, cattle and ponies were based on a smaller number of faecal samples, the list of plants dispersed by them is not included in Appendix 1.

Tests for germination of seeds: Some samples of the faeces and droppings were left *in situ* and observed for germination. To determine germinability of mammal-dispersed seeds, seeds of some of their preferred plants were sown in a nursery. The number of seeds put for germination as well as the number of faecal samples left *in situ* were small and hence quantitative information is not given in this paper. The study was conducted from January 1987 to December 1988.

RESULTS AND DISCUSSION

Altogether seeds of 59 species of plants were dispersed by animals studied (Appendix 1). The number of plants dispersed by bonnet macaque was 39, civet 23, fruit bat 36, jackal 22 and 12 were dispersed by spotted deer. Though seeds of many plants were observed as dispersed by these animals, only seeds of certain species were frequently encountered in the faeces of each animal. The details of these are given in Tables 1-5.

Bonnet macaque: The seeds of *Prosopis chilensis, Scutia myrtina, Lannea coromandelica* and *Manilkara hexandra* were largely dispersed by bonnet macaques (Table 1). The frequency of occurrence of *P. chilensis* seeds was high (37.6%). Also, it was observed that the monkeys eat a lot of unripe fruits. Their dung contained the unripe fruits of *Drypetes sepiaria, Scutia myrtina* and *Manilkara hexandra,* which are among their preferred fruits.

TABLE 1
FREQUENCY OF OCCURRENCE OF SEEDS IN BONNET MACAQUE DUNG AT PT. CALIMERE (569 SAMPLES)

Plant species	No. of occurrences	% of occurrence
Prosopis chilensis	214	37.6
Scutia myrtina	124	21.8
Lannea coromandelica	89	15.6
Manilkara hexandra	78	13.7
Drypetes sepiaria	72	12.7
Ficus benghalensis	63	11.1
Others (33 species)	< 25	—

The studies conducted at various tropical regions show that large arillate or compound; aromatic; brown, green, orange, yellow and white fruits are typical arboreal mammal fruits (Howe 1986). As such fruits are not available in this sanctuary, it seems that the monkeys consume large quantities of fruits of two introduced species, *Prosopis chilensis* and *Pithecellobium dulce*; the latter is confined to a small area in the sanctuary. That the bonnet macaque, though widespread in south India, is not an original denizen of Pt. Calimere, also indicates the non-availability of native ideal arboreal mammal-fruits.

The bonnet macaque's role in the dispersal of plants is negligible. They eat considerable quantities of unripe fruits and by visiting plants laden with large fruit crop, disturb the birds which are the legitimate dispersal agents of that particular plant species. Moreover the monkeys move in a troop in their territory, eat the fruit crop of several species and defecate the seeds *en masse* under their roosting trees. This type of dispersal is unsuccessful for two reasons: consumption of unripe fruits by the macaques and a higher degree of competition between the seeds of various plant species for establishment.

Ridley (1936) recorded that when monkeys find a tree or liane in fruit, they attack it vigorously, tearing off branches and discarding more than they eat. They often bite off pieces of a fruit, then drop it and seize another. Howe (1980) mentioned that arboreal mammals, especially monkeys, often spit out or knock down more fruits than they actually ingest, reducing their reliability as agents of fruit removal. Van der Pijl (1982) mentioned that primates are late-comers, taking advantage of ecological opportunities that open up incidentally, and forming incidental connections. They are mostly destructive, eating everything edible, ripe or unripe, also seeds and leaves, soft- or hard-skinned fruits; they may or may not be instrumental in dispersal.

TABLE 2
FREQUENCY OF OCCURRENCE OF SEEDS IN CIVET SCATS AT PT. CALIMERE (107 SAMPLES)

Plant species	No. of occurrences	% of occurrence
Manilkara hexandra	43	40.2
Zizyphus oenoplia	18	16.8
Hugonia mystax	16	15
Grewia rhamnifolia	6	5.6
Others (19 species)	< 5	—

TABLE 3
FREQUENCY OF OCCURRENCE OF SEEDS IN JACKAL SCATS AT PT. CALIMERE (514 SAMPLES)

Plant species	No. of occurrences	% of occurrence
Cassia fistula	249	48.4
Zizyphus oenoplia	110	21.4
Manilkara hexandra	54	10.5
Syzygium cumini	53	10.3
Others (18 species)	< 25	—

Small Indian civet: The seeds of *Manilkara hexandra* and *Zizyphus oenoplia* were commonly noticed in the scats of civet (Table 2). Faecal samples were collected from one of the regular defecation sites, namely the platform of one of the wells in the sanctuary. Van der Pijl (1982) also mentioned that civets have the pleasant habit of defecating on fixed open spots, and he could review the complete yearly menu in Indonesia. During January 1988 four seedlings of *Manilkara hexandra* were noticed in the crevices of the platform. This observation shows that the civet definitely helps in the regeneration of this plant. Ridley (1936) stated that this species prefers to eat sweet juicy fruits and does not eat figs. In Pt. Calimere, most of the fruits eaten by the civet are sweet and include fig fruits, e.g. *Ficus benghalensis*.

Jackal: The jackal picks up fallen fruits and defecates the seeds after digesting the pulp. Seeds of *Cassia fistula*, *Zizyphus oenoplia*, *Manilkara hexandra* and *Syzygium cumini* were commonly noticed in their scats (Table 3). The seeds of *C. fistula* are largely dispersed by this animal. The jackal carries away to some distance the pods that fall under the tree, bites them open and eats the sweet pulp, swallowing the seeds along with it. The seeds are dropped in their faecal scats. The pods of *C. fistula* ripen by May and are available until November. During this period most jackal scats contained only *C. fistula* seeds. The frequency of occurrence of *C. fistula* seeds was 48.4%. During December 1987, 34 seedlings sprouting from 11 jackal scats were noticed in one site in the study plot, with one to five seedlings in each scat. It clearly shows that the jackal helps in the regeneration of this plant. Troup (1921) observed that the seeds of *C. fistula* treated by the jackal (fruits eaten and seeds defecated) germinated successfully, while none of the untreated seeds germinated.

Cassia fistula seeds were occasionally noticed in cattle dung. The monkeys eat mostly unripe fruits. Hence, the widespread distribution of this plant in the sanctuary might be due to the efficient dispersal of seeds by jackal. In addition, seedlings of *Syzygium cumini* and *Salacia chinensis* were commonly noticed sprouting from jackal scats.

Shortnosed fruit bat: This species visits fruiting plants at night to pluck the fruits and carry them to nearby trees and eat at leisure. They chew the fruit pulp and spit out the seeds under their roosts. They do not swallow the seeds. Seeds of *Atalantia monophylla* and *Manilkara hexandra* were commonly noticed under their roosts. The frequency of occurrence of *A. monophylla* seeds in bats spit-outs was

TABLE 4
FREQUENCY OF OCCURRENCE OF SEEDS SPAT OUT BY SHORTNOSED FRUIT BAT AT PT. CALIMERE (631 SAMPLES)

Plant species	No. of occurrences	% of occurrence
Atalantia monophylla	206	32.6
Manilkara hexandra	162	25.7
Salacia chinensis	82	13
Plecospermum spinosum	52	8.2
Ficus benghalensis	39	6.2
Others (31 species)	< 30	—

32.6% (Table 4). Seeds were noticed in very few faecal samples (2 out of 514) of jackal, and no other animal eats this fruit. Seedlings of this plant, ranging from five to 35, were noticed under 13 roosting sites of this bat during January 1988. Our studies show that this animal is the only dispersal agent of *A. monophylla*. Moreover, this observation forms the first record of a citrus type of fruit dispersed by a suitable disperser in the natural environment (Balasubramanian 1990b). In addition, this bat is the only dispersal agent for *Madhuca longifolia*.

Seedlings of *Plecospermum spinosum*, *Salacia chinensis*, *Madhuca longifolia*, *Diospyros ferrea* and *Memecylon umbellatum* sprouting from the seeds dropped by this bat were commonly noticed under their roosts.

The shortnosed fruit bat also eats the fruits of cultivated species such as *Manilkara zapota* (Sapotaceae), *Psidium guajava* (Myrtaceae) and *Calophyllum inophyllum* (Guttiferae). The seeds and the fruit remains were noticed under their feeding roosts in the villages adjacent to the forest. However, the fruits of *C. inophyllum* are adapted for dispersal by water. Another interesting feature about bat dispersal in Pt. Calimere is the dispersal of seeds of cultivated plants from the village to the forest. Seeds of *Madhuca longifolia* and *Polyalthia longifolia* were noticed under the roosts of this bat in the forest area adjoining the village.

Spotted deer: The deer is confined to the dense thickets of the forest. It devours the fallen fruits of woody plants and seeds are defecated in the pellets. Seeds of *Catunaregam spinosa* (= *Randia dumetorum*), *Dichrostachys cinerea*, *Cassia auriculata* and *Prosopis chilensis* were commonly noticed in their pellets (Table 5). All these fruits are available during the dry season, i.e. April to August.

TABLE 5
FREQUENCY OF OCCURRENCE OF SEEDS IN CHITAL PELLETS AT PT. CALIMERE (452 SAMPLES)

Plant species	No. of occurrences	% of occurrence
Catunaregam spinosa	302	66.8
Dichrostachys cinerea	74	16.4
Cassia auriculata	64	14.2
Prosopis chilensis	51	11.3
Others (8 species)	< 15	—

The occurrence of seeds of these fruits, especially *C. spinosa* during dry season shows that fruits are eaten by spotted deer when there is non-availability of grasses and forbs. In Bandipur Tiger Reserve, Johnsingh (1981) observed the large scale consumption of fruits of *Emblica officinalis* and *Xeromphis spinosa* (= *Catunaregam spinosa*) by spotted deer during the dry season. To study the germinability of seeds dropped by deer, 25 seeds each of *P. chilensis* and *C. spinosa* were planted in a nursery. Successful germination of seeds (70 to 90%) was recorded for both species. Moreover, in the study sites, a large number of seedlings of *C. spinosa* sprouting from chital pellets were noticed during the following rainy season, i.e. September to December. The fruits of *C. spinosa* and *P. chilensis* are eaten for their pulp.

Indian wild boar: The wild boar is very common in the forest and has been noticed feeding on the roots of sedges, grasses and other plants. They also pick up fallen fruits. During the first year of this study, 18 faecal samples were collected and searched for seeds, of which 12 samples had *Prosopis chilensis* seeds. A few samples contained a few seeds of *Manilkara hexandra* and *Zizyphus oenoplia*. One sample had a number of *Ficus benghalensis* seeds; another had many seeds of *Ficus tsjakela* and one was full of paddy grains which showed the animal's crop raiding habit. The observations show that the wild boar disperses *P. chilensis* seeds on a large scale.

Cattle: While browsing, several fruits are eaten accidentally. Fallen fruits are also eaten. A total of 12 dung samples were collected and analysed during the first year. Seeds of *Catunaregam spinosa*, *Prosopis chilensis* and *Dichrostachys cinerea* were commonly noticed in the dung. Natarajan *et al.* (1984) recorded 410 seeds (range 53-567) of *P. chilensis* in 15 dung samples and noticed about 100 seedlings sprouting from a dung mass. Seeds of *Cassia auriculata, C. fistula, C. roxburghii, Abrus precatorius, Mucuna pruriens, Azima tetracantha* and *Solanum trilobatum* were also noticed. The fruits of *A. precatorius, M. pruriens, A. tetracantha* and *S. trilobatum* might have been eaten accidentally, while browsing. Most of the fruits preferred by cattle are dry indehiscent fruits. It is interesting to note that the cattle, which are identified as an important component of the fauna of this type of forest, i.e. dry evergreen thickets (Champion and Seth 1968), have a significant role in the establishment of some plant species. In the absence of spotted deer (which was introduced to this forest), plants such as *Catunaregam spinosa, D. cinerea* and *Cassia auriculata* could only be dispersed by cattle. Successful germination of seeds of *Catunaregam spinosa, D. cinerea* and *Cassia auriculata* were noticed from cattle dung in the study sites.

Feral ponies: Seeds of *Prosopis chilensis, Dichrostachys cinerea* and *Cassia auriculata* were found in their dung. Out of 10 samples analysed, all contained the seeds of *P. chilensis*.

Blackbuck and blacknaped hare: A preliminary analysis of some samples (10 for each species) showed the absence of seeds of any woody species. However, a few seeds of *P. chilensis* were noticed in a few pellets of blackbuck (Natarajan, pers. comm.).

Common mongoose: Prater (1980) mentioned that the common mongoose preys upon animals and also feeds on carrion, but as a variation to the regular diet, consumes fruits and roots. Field observations indicated that the mongoose does not play a significant role in plant dispersal as it eats the pulp and drops the seeds under the parent plant. Fruits of *Manilkara hexandra, Glycosmis pentaphylla* and *Hugonia mystax* were observed to be eaten.

Threestriped palm squirrel: Direct observations on their feeding habits reveal that they mostly visit fruit-bearing trees, for eating the seeds. Fruits of 38 plant species had been observed to be eaten by this squirrel. Fruits of *Prosopis chilensis* and *Cassia fistula* were eaten for the pulp. Among the remaining plant species, except in the case of *Ficus* spp. all the others were visited for eating the seeds. Owing to their minute size and smoothness, seeds of *Ficus* spp. might escape from being injured. Hence, it is inferred that the squirrel is not an efficient dispersal agent in this forest.

Indian gerbille: The Indian gerbille was recorded to eat the seeds of *Cassia auriculata* and *Prosopis chilensis*. Pods of these two plant species were noticed at the gerbille burrows. While carrying a number of fruits of these plants to their burrows, some seeds might be dropped and left uneaten and may have a chance to germinate. Though this animal is a seed predator, it might also help in low key dispersal of the species.

Unidentified rodents: The fruits of *Prosopis chilensis* were stored in large quantities in the nests of a longtailed tree mouse *Vandeleuria* sp. (?). Several pods had been opened and seeds eaten, and the remnants of seeds were found in the nests.

Seeds of the legume *Crotalaria verrucosa* were also found eaten by a rodent. In this case, the remnants of fruits and seeds were left in small heaps near the plant itself. Seeds that escaped being eaten are carried away by ants to their burrows.

Van der Pijl (1982) also mentioned that rodents such as squirrels, rats and hamsters destroy the seeds of oaks, pines and cereals and are considered to be especially harmful in American arid regions although some seeds germinate after rains.

Mammal-dispersed plants and their fruit characteristics: Even though seeds of 59 plant species were found in the droppings of the animals studied, the frequency of occurrence of seeds of many plant species was very low. Based on their frequency of occurrence in the faeces and the availability of other dispersal agencies (water, wind and animals other than mammals), ten plants are identified as mammal-dispersed species. They are: *Atalantia monophylla, Lepisanthes tetraphylla, Mimusops elengi, Catunaregam spinosa, Gmelina asiatica, Madhuca longifolia, Cassia fistula, C. auriculata, Dichrostachys cinerea* and *Prosopis chilensis*. However, fruits of *P. chilensis* and *G. asiatica* are dispersed by water also. Though *M. longifolia* trees are not encountered in the forest, their saplings were recorded in the forest close to the village.

The seeds of *P. chilensis* and *Pithecellobium dulce* were found to be dispersed by monkeys. *Atalantia monophylla, Lepisanthes tetraphylla, Madhuca longifolia, Mimusops elengi* and *G. asiatica* are identified as bat fruits. *L. tetraphylla* and *C. fistula* are dispersed by jackal. *Dichrostachys cinerea, Catunaregam spinosa, Cassia auriculata* and *P. chilensis* are largely dispersed by ruminants. None of the above mentioned fruits are dispersed by other animals. The characteristics of fruits of these mammal-dispersed plants are summarised in Table 6.

Co-evolutionary relationship between plants and animals: The inferences derived from this study show the existence of some obligatory relationship between some plants and animals of this forest. For example, seeds that could not be dispersed by birds (owing to large-seeded fruits and unattractive colour of fruits etc.), or any other agencies (due to structural adaptations) were successfully dispersed by some mammals. In this community it appears that plants and animals do not simply co-occur but they have co-evolved, one depending on the other for its survival and existence.

The dispersal of *Atalantia monophylla* in this forest is only by the shortnosed fruit bat. This fruit is not eaten by birds, which might be due to the unattractive colour of the fruit or the large seeds. These fruits are apparently adapted for consumption by mammals. As the fruits are largely eaten and dispersed by the shortnosed fruit bat, it seems there is a co-evolutionary relationship between this plant and the bat.

TABLE 6
CHARACTERISTICS OF FRUITS OF MAMMAL-DISPERSED PLANTS IN PT. CALIMERE SANCTUARY

Family & Species	Fruit type	Fruit colour	No. of seeds in fruit	Wet fruit mass (g) n = 10	Dimensions of fruit (mm) n = 10	Wet seed mass (g) n = 10	Dimensions of seed (mm) n = 10
Rutaceae							
Atalantia monophylla	B	G	2-5	5	20x19	0.48	13x9
Sapindaceae							
Lepisanthes tetraphylla	D	Y	3	6.6	23x20	0.54	14x8
Caesalpiniaceae							
Cassia auriculata	P	Br	7-13	—	120x15.5	—	6.4x4.6
Cassia fistula	P	B	71-122	82	620x17	0.13	10x7
Mimosaceae							
Dichrostachys cinerea	P	B	4-6	—	—	—	4.3x3.4
Prosopis chilensis	P	Y	19-30	11.3	184x11	—	6.6x4.4
Rubiaceae							
Catunaregam spinosa	B	G	87-102	—	24x22	—	4.6x3.2
Sapotaceae							
Madhuca longifolia	B	Br	1-4	20	51x28	4	45x15
Mimusops elengi	B	R	1	3.4	25x23	0.72	16x10
Verbenaceae							
Gmelina asiatica	D	Y	1	6.2	24x22	0.57	14x8.5

Fruit type: B = berry; D = drupe; P = pod; – = measurements not taken.
Fruit colour: B = black; G = green; R = red; Y = yellow; Br = brown.

Similarly, the dispersal of *Lepisanthes tetraphylla* and *Plecospermum spinosum* were done by jackal and shortnosed fruit bat. These two native plant species have big-seeded fruits which cannot be dispersed by birds. Whenever birds visit big-seeded fruits, they eat only the pulp and drop the seeds under the parent plant. In the case of these two plants, jackals ingest the whole fruit and defecate the seeds. Fruit bats carry the fruits to nearby places and drop the seeds after chewing the pulp.

The fruits of *Cassia fistula* which possess dry indehiscent pods form one of the major foods for jackal during the dry season and this animal is the main dispersal agent for this plant. The inter-relationship between this plant and animal needs special mention here. Other than jackal, the dispersal of this plant is only by cattle, but on a low key.

The fleshy fruits of *Catunaregam spinosa* and the dry indehiscent fruits of *Cassia auriculata* and *Dichrostachys cinerea* are eaten and dispersed by cattle and spotted deer.

Importance of the exotic, *Prosopis chilensis:* The fruits of the introduced plant, *Prosopis chilensis*, form an important food source for the bonnet macaque, which is an introduced species in this forest. This fruit also forms a major food source for wild boar, cattle, feral ponies and spotted deer. In addition, rodents and blackbuck also eat the fruits. *Prosopis chilensis* is an exotic and was introduced in the forest about 37 years ago. It is spreading fast and is considered a threat to the native vegetation. This study shows that this plant forms an important food source for most of the mammals; its fruits are eaten for the sweet pulp. The plant has an extended fruiting season with a peak in summer.

Van der Pijl (1982) mentioned that ruminants in African savannah regions rely to a considerable extent on fruits. He recorded that many leguminosae, especially *Acacia* species, offer leathery nutritive pods adapted for dispersal by ruminants. They are rich in protein and digestible carbohydrates, providing these at a time when little grass is available. He further recorded that the ruminant-dispersed pods have a distinct smell which is attractive to cattle. Another adaptation is the extreme hardness of the smooth seeds, making them resistant to strong molars as is evident in *Tamarindus, Dichrostachys, Acacia* and those *Cassia* species with hard, indehiscent pods of the type of *C. fistula. Acacia arabica* and *A. horrida* are mentioned as pioneers in grassland, spread by ruminants.

The large scale consumption of *Prosopis* pods by various species of mammals in Pt. Calimere might be due to the nutritive value of the pods. Ridley (1936) recorded that there is no doubt that it is due to the sweet pulp of the pods of *Prosopis chilensis* that this genus is so widely spread and abundant in suitable areas.

Syndromes of mammal-fruits: Howe and Westley (1986) described the dispersal syndromes of mammal-fruits (Table 7). The fruit characters of mammal-dispersed plants in Pt. Calimere correspond with the results of Howe and Westley (1986) and are given in Table 8.

TABLE 7
SYNDROMES OF MAMMAL-FRUITS (AFTER HOWE & WESTLEY 1986)

Agent	Colour	Odour	Form
Hoarding mammals	Brown	Weak or aromatic	Tough thick-walled nuts; indehiscent.
Arboreal frugivorous mammals (monkeys)	Brown, green, white, orange, yellow	Aromatic	Often arillate, seeds or drupes often compound.
Aerial frugivorous mammals (bats)	Green, white, pale yellow	Aromatic or musty	Various, often pendant or dangling.
Terrestrial frugivorous mammals (ruminants, elephants)	Often green or brown	None	Tough, indehiscent, often > 50 mm long.

TABLE 8
SYNDROMES OF MAMMAL-FRUITS OF PT. CALIMERE

Agent	Colour	Odour	Form
Arboreal frugivorous mammals (monkeys)	Green or yellow	Aromatic	Seeds arillate, compound fruits.
Aerial frugivorous mammals (bats)	Green, yellow, brown	Aromatic or musty	Often pendant.
Terrestrial frugivorous mammals (ruminants)	Brown, green	None	Tough, indehiscent, often >50 mm long.
Terrestrial frugivorous mammals (jackals)	Yellow, black, brown	Sweet	Often fleshy, often >25 mm long.

As far as terrestrial frugivores are concerned, two classes of mammal-fruits identified at Pt. Calimere are (1) Fruits dispersed by herbivores (ruminants), most of which have tough indehiscent pods. An exception is *Catunaregam spinosa.* (2) Fruits dispersed by omnivores (jackal), most of which are fleshy. An exception is *Cassia fistula.*

CONCLUSIONS

From this study it is inferred that (1) Among the mammals of this dry evergreen forest biotope, the jackal and shortnosed fruit bat play a vital role in the dispersal of various plant species. (2) The exotic plant *Prosopis chilensis* has now a definite role to play in this ecosystem, where introduced animals such as bonnet macaque and spotted deer are present. Also, with the increasing population of cattle, wild boar and to some extent feral ponies, the existence of *Prosopis chilensis* in this habitat seems impossible to eradicate. However, it is necessary to make a detailed study on the impact (threat) of *Prosopis* to the native vegetation in this Sanctuary. Hence, while formulating a management programme for conserving this ecosystem, the significance of the inter-relationships that exist between the plants and mammals discussed in this paper should be taken into consideration.

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APPENDIX 1

SYSTEMATIC LIST OF PLANT SPECIES DISPERSED BY VARIOUS MAMMALS AT PT. CALIMERE SANCTUARY

Family	Species	BM	SC	JL	FB	SD
Anonaceae	*Polyalthia longifolia*				+	
Menispermaceae	*Trinospora cordifolia*	+			+	
Capparidaceae	*Crateva adansonii*	+			+	
Flacourtiaceae	*Flacourtia indica*	+	+	+	+	
Tiliaceae	*Grewia rhamnifolia*	+	+	+	+	
Linaceae	*Hugonia mystax*	+	+	+	+	
Rutaceae	*Atalantia monophylla*			+	+	
	Glycosmis pentaphylla		+	+		
	Toddalia asiatica		+			+
Ochnaceae	*Ochna obtusata*			+	+	
Meliaceae	*Azadirachta indica*	+			+	
	Walsura trifolia				+	
Olacaceae	*Olax scandens*	+		+	+	
Opiliaceae	*Cansjera rheedi*				+	
Hippocrateaceae	*Salacia chinensis*	+	+	+	+	
Rhamnaceae	*Scutia myrtina*	+	+	+	+	+
	Zizyphus mauritiana		+	+	+	
	Zizyphus oenoplia	+	+	+	+	+
Vitaceae	*Cissus vitiginea*	+				
Sapindaceae	*Lepisanthes tetraphylla*	+		+	+	
Anacardiaceae	*Lannea coromandelica*	+			+	
Caesalpiniaceae	*Cassia auriculata*					+
	Cassia fistula			+		
	Dichrostachys cinerea					+
	Tamarindus indica		+			
Mimosaceae	*Pithecellobium dulce*	+				
	Prosopis chilensis	+	+	+		+
Myrtaceae	*Syzygium cumini*	+	+	+	+	+
Melastomataceae	*Memecylon umbellatum*	+	+	+	+	
Cucurbitaceae	*Coccinia grandis*	+	+	+	+	
Rubiaceae	*Benkara malabarica*	+				
	Canthium dicoccum	+	+			
	Canthium parviflorum	+			+	
	Catunaregam spinosa					+
	Ixora pavetta		+	+		
	Morinda sp.				+	
	Pavetta breviflora	+				
Oleaceae	*Jasminum angustifolium*	+				
Sapotaceae	*Madhuca longifolia*				+	
	Manilkara hexandra	+	+	+	+	+
	Mimusops elengi	+			+	
Ebenaceae	*Diospyros ferrea*	+	+	+	+	
Salvadoraceae	*Azima tetracantha*	+	+			
	Salvadora persica	+				
Apocynaceae	*Carissa spinarum*	+	+		+	
Cordiaceae	*Cordia obliqua*	+		+	+	
	Ehretia ovalifolia	+				

BM = Bonnet macaque; SC = Small Indian civet; JL = Jackal; FB = Shortnosed fruit bat; SD = Spotted deer.

Appendix 1 — Contd.

SYSTEMATIC LIST OF PLANT SPECIES DISPERSED BY VARIOUS MAMMALS AT PT. CALIMERE SANCTUARY

Family	Species	BM	SC	JL	FB	SD
Solanaceae	*Solanum trilobatum*				+	
Convolvulaceae	*Rivea hypocrateriformis*	+				
Verbenaceae	*Gmelina asiatica*				+	
	Premna serratifolia	+	+			
Euphorbiaceae	*Breynia vitis-idaea*	+				
	Drypetes sepiaria	+			+	
	Securinega leucopyrus		+			
Moraceae	*Ficus benghalensis*	+	+		+	+
	Ficus microcarpa	+			+	+
	Ficus tsjakela	+			+	+
	Plecospermum spinosum			+	+	
Liliaceae	*Asparagus racemosus*	+				

BM = Bonnet macaque; SC = Small Indian civet; JL = Jackal; FB = Shortnosed fruit bat; SD = Spotted deer.

ETORPHINE AND ACEPROMAZINE COMBINATION FOR IMMOBILISING WILD INDIAN ELEPHANTS *ELEPHAS MAXIMUS*[1]

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Key words: acepromazine, elephants, *Elephas maximus*, etorphine, immobilization, Immobilon, Revivon.

Four adult wild Asian elephants (*Elephas maximus*) were administered a combination of etorphine (ETP) hydrochloride and acepromazine (ACP) maleate (Immobilon) using projectile darts as syringes and a powder rifle as projector. Diprenorphine hydrochloride (Revivon) was the antagonist used for revival. The total dose of ETP and ACP varied between 6.12-8.6 mg and 25-35 mg respectively. Immobilization was complete in two females and partial in the tusker. The fourth animal, a female, died of traumatic cardiac arrest, probably incurred during fall. Induction time was 12 minutes in the only case when visual contact could be maintained. The significance of some of the operational constraints and unexpected outcomes are discussed.

Introduction

Free living Asian elephants *Elephas maximus* have been chemically immobilised for the purposes of domestication, translocation and radio-collaring. On most occasions, etorphine hydrochloride, a highly potent derivative of thebaine (Harthoorn 1966) has been used, either alone (Gray and Nettashinghe 1970, Jainudeen and Khan 1977) or in combination with acepromazine maleate (Jones 1975, Sale *et al.* 1986, Mohd-Shariff *et al.* 1991). Though the use of etorphine in elephants is not supported by thorough pharmacological studies, valuable clinical experience gained over the years has shown that this drug can be used successfully for immobilising both African (Pienaar *et al.* 1966, Wallach and Anderson 1968, Ebedes 1975) and Asian species of elephants. One of the major advantages of etorphine is the very low quantity of drug required, a rapid induction and the availability of specific antagonists, cyprenorphine and diprenorphine hydrochlorides.

As a part of the ongoing study on the ecology of the Asian elephant in Rajaji National Park of Dehra Dun forest division (Uttar Pradesh), elephants have been immobilised by the Wildlife Institute of India since 1983 for the purpose of radio-collaring. The results of the first six cases of drug immobilisation was reported by Sale *et al.* (1986). Subsequently 11 elephants have been darted for the purpose of either fitting new radio-collars or replacing the old ones. The results of the last four cases, carried out by this team in 1990, are reported here.

Material and Methods

The equipment used in this operation consisted of a standard Distinject N60 powder rifle (Peter Ott & Co., Basle, Switzerland) as projector, 5 ml aluminium syringe barrels (fitted with a collared needle at one end and a feathered stabilizer at the other) as projectile-darts and colour-coded powder charges for short, medium and long distances, as explosives.

The drug used for immobilisation was Immobilon (Reckitt & Colman) which contains 2.45 mg of etorphine hydrochloride and 10 mg of acepromazine maleate per ml of the solution. A specific morphine antagonist Revivon (Reckitt & Colman), which contains 3 mg of diprenorphine hydrochloride per ml of the solution, was

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used for remobilization. Another morphine antagonist Narcan (Wintrop Lab., Surbiton, England), which contains 0.4 mg/ml of naloxone hydrochloride, was always kept ready to reverse the effects of any accidental administration of Immobilon into humans.

The capture team consisted of one senior scientist in charge of the operation, two field biologists, two officials from the Forest Department, one veterinarian, two field assistants, two armed guards and two domestic elephants. The usual procedure was to locate elephants in the forest during the early hours of the day. Elephants found in dense vegetation and difficult terrain were avoided. As far as possible, a relatively flat and open area was chosen for the operation. A specific total dose (TD) of Immobilon was predetermined and the target animal was later chosen for the amount of drug taken.

All elephants were darted, either on foot (n=3) or from elephant back, only when they were approachable within a distance of 20-30 m. The site of drug administration differed according to the position of the operator at the time of darting. Upon darting, the induction time (IT) (time lag between drug administration and collapse of the animal) was noted. Whenever visual contact (VC) with the darted animal was lost, the team divided into three or more search parties, with radio- communication sets, to track the animal. All animals were examined for vital pulmonary and cardiac functions. Body measurements were taken while radio-collars were being fixed. Based on measurements of SH (shoulder height) and FFC (front foot circumference) an approximate value of body weight (BW) of different individuals was calculated (Sukumar *et al.* 1988). The dosage of etorphine per unit body weight (μg/kg BW) was obtained to get an idea about dosage rate. After completion of the operation, an appropriate dose of the antagonist (Revivon) was administered intravenously into the ear vein. Recovery time (RT) (time lag between administration of the antagonist and the animal getting up) was noted following revival.

RESULTS

For darting four elephants, six attempts had to be made. Attempts failed twice, once because of equipment failure and on the second occasion because the dart hit the flapping ear of the animal. Three females and one tusker were darted with a TD of 2.5 to 3.5 ml of Immobilon (Table 1). Due to dense vegetation and individual difference in reaction to the impact of the dart, VC with the darted animal was lost on three occasions. IT was 12 minutes in the only case when VC could be maintained. In cases where VC was lost, recumbent animals were located following a search time (ST) of 22 to 86 minutes (Table 2).

The required complete immobilisation, characterised by deep narcosis, closed eye-lids and areflexia, could be achieved only with the first two females. Though recumbency was achieved, immobilisation was only partial in the case of the tusker. The animal had travelled a distance of about 5 km before succumbing to the effects of the drug. As it still maintained a reasonable control over its trunk, a subsequent dose of 1 ml of Immobilon (2.45 mg of etorphine and 10 mg of acepromazine) had to be administered in two doses. The first dose of 0.5 ml was given 100 minutes after darting and the second, 30 minutes later.

All animals, except one, fell in lateral recumbency. The fourth animal was located on a 45° slope, after ST of 62 minutes, head downhill in sternal recumbency (SR). Taking into consideration the posture and the one hour lapse in locating the animal, the antagonist was administered intravenously even before vital functions could be checked. When the animal failed to recover, she was declared dead after subsequent examination. Necropsy revealed near empty ventricles and extensive areas of haemorrhage in the apical lobes of the lungs. Death was attributed to traumatic cardiac arrest.

The total down time (time lag between the

TABLE 1
DETAILS OF FOUR CASES OF ELEPHANT IMMOBILISATION BY DARTING

Animal no.	Date	Age/Sex	Immobilon (mg)		Revivon (mg)	Etorphine per kg BW (µg)	IT (min.)	RT (min.)	DnT (min.)	Comments
			Etorphine	Acepromazine						
1.	23 Nov. '90	Adult female	6.743	27.5	12	2.33	12	6	52	Had a 2 year old calf. Induction began with ataxia and sudden fall involuntarily. Recovery was smooth.
2.	25 Nov. '90	Adult male	8.603 1.233 1.233 (Total3 11 mg)3	35.0 5 5 (Total 45 mg)	15	1.393	—	26	Not less than 180	Was only partially immobilised. An additional dose of 1 ml of Immobilon was given in 2 doses.
3.	26 Nov. '90	Adult female	6.123	25.0	10.5	2.353	—	7	Not less than 62	The immobilised animal could not be approached for 30 min because of mock charges by its suckling calf. Later it moved away with a young tusker.
4.	13 Dec. '90	Adult female	6.743	27.5	12	2.363	—	—	—	When found, head was down-hill, all legs flexed, hind legs backwards and forelegs below chest. Evidence showed that induction occurred while coming down-slope, the animal landing in sternal recumbency dragging itself 3-5 m down.

IT–Induction time, RT-Recovery time, DnT-Down time (all in minutes).

TABLE 2
MEASUREMENTS OF SOME MORPHOMETRIC, PHYSIOLOGICAL AND ECOLOGICAL PARAMETERS OF FOUR DARTED ELEPHANTS

Animal	Morphometric			Physiological			Ecological		
no.	SH (cm)	FFC (cm)	BW (kg)	Respiration rate (min.)	Pulse/ (min.)	Temperature (°F)	Visual Contact	Search Time (min.)	Distance Travelled (km)
1.	243	130	3000[1], 2891[2]	6	42	97.8	Maintained	—	0.2
2.	320	165	5500[1], 6183[2]	7	36	97.8	Lost	86	5
3.	235	116	2500[1], 2608[2]	6	36	95.8	Lost	22	0.2
4.	*	119	2700[1], 2854[2]	—	—	96.8	Lost	62	0.15

* Not measured due to sternal recumbency.

BW = Body Weight, SH = Shoulder Height, FFC = Front-foot circumference.

[1] Field estimate of body weight, [2] Calculated from SH (or FFC).

fall of the animal and its getting up) varied between 52 minutes and not less than 180 minutes. The details of morphometry and vital signs of cardiac and pulmonary functions are given in Table 2. The process of revival was slightly prolonged in the tusker, which took 26 minutes to regain its feet. Following administration of the antagonist, the animal moved into SR in 9 minutes, but got up only 17 minutes later. Recovery was uneventful in the other two cases.

DISCUSSION

The constraints while immobilising wild elephants differ a great deal from those for captive elephants, even when the same drugs and combinations are used. Reports of drug-immobilisation in captive Asian elephants (Jainudeen 1970, Jainudeen *et al.* 1971, Bongso and Perera 1978) have been incident-free when compared to reports in the wild (Jainudeen and Khan 1977, Sale *et al.* 1986) which is fraught with operational difficulties and unpredictable outcomes. In this context, four aspects in the present short series need to be discussed.

In the form of equipment failure, one of the unexpected incidents was the obstructive passage of the dart through the barrel despite a perfect explosion of the charge. It becomes mandatory, therefore, to not only clean the barrel every time, but also to check the passage of the dart prior to loading with the drug for darting.

The partial immobilisation in the case of the tusker can be attributed to a disproportional increase in the TD in relation to BW. For individuals within a species, it is safer to administer dosage of etorphine that would be proportional to their BW (Wallach 1969). As a result of this under-dosing, the animal received only 1.39 μg/kg BW of etorphine. This might be the reason, besides individual differences in post-darting reaction, for it to travel a distance of 5 km. For animals which are likely to bolt on being struck by a dart, administration of adequate dose of etorphine becomes essential to prevent incomplete induction. To avoid incidence of under-dosing, a practice of predicting the amount of etorphine that will be injected per unit BW, following the use of the intended TD, can be adopted. The approximate BW values can be obtained from a visual estimate of SH or impression estimate of the FFC of the target animal.

The slightly longer RT (26 minutes) observed in the case of the tusker is difficult to explain. Though a considerably prolonged RT has been reported in a few cases (Wallach and Anderson 1968, Gray and Nettashinghe 1970, Sale *et al.* 1986), it is still to be established whether adding acepromazine to etorphine, which is done with the intention of achieving a smoother induction and residual sedation, would cause any appreciable delay in RT following a perfect intravenous administration of an appropriate dose of the antagonist.

Whenever VC is lost, a timely location of the immobilised animal becomes vital, particularly in cases where the fallen beast is in SR. Elephants in prolonged SR show signs of dyspnoea due to the enormous pressure exerted by the intestines and other viscera against the diaphragm (Pienaar *et al.* 1966). However, in the case of the fourth elephant, a traumatic cardiac arrest preceded a possible anoxia which could have occurred at a later stage, the visceral pressure on the diaphragm being further augmented by the head down-hill position (Table 1). Clausen *et al.* (1984) reported a similar incident, but in ruminants, where a musk ox bull collapsed into SR while coming down-hill. On post-mortem, they found endocardial haemorrhage and blood-stained froth in the lungs. While one can choose an appropriate site for darting animals, predicting either the direction or location of fall following induction is impossible.

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SIDIDAE OF TAMIL NADU (CRUSTACEAE : CLADOCERA)[1]

K. VENKATARAMAN[2]

(With five text-figures)

Key words: Cladocera, *Diaphanosoma excisum, D. sarsi, D. senegalensis, Latonopsis australis*, Sididae.

The taxonomy of all the available species of the family Sididae from ponds, marshes, man-made reservoirs and rice fields of Tamil Nadu, ia discussed. Females of *Latonopsis australis* Sars, *Pseudosida bidentata* Herrick, *Diaphanosoma excisum* Sars, *D. sarsi* Richard and *D. senegalensis* (Gauthier) and males of *L. australis* Sars and *D. excisum* Sars are recorded for the first time in India. A brief description and illustrations have been made for some important distinguishing characters to reduce the confusion in identification of different species of the family Sididae.

INTRODUCTION

Although Cladocera are among the commonest freshwater microcrustaceans, a perusal of literature of this group shows that they are poorly known taxonomically throughout India (Biswas 1964, 1971; Nayar 1971, Michael 1973, Michael and Sharma 1988, Venkataraman 1983). There is no comprehensive systematic study in south India except that of Michael (1973), which is a preliminary attempt to identify eight of the common genera occurring in Madurai. The present work was undertaken to study the taxonomy of Cladocera of Tamil Nadu based on intensive and extensive sampling and detailed study of all available species. Over 531 samples were collected from all types of habitats. This paper deals with the description of females and some of the males of *Latonopsis australis* Sars, *Pseudosida bidentata* Herrick, *Diaphanosoma excisum* Sars, *D. sarsi* Richard and *D. senegalensis* (Gauthier).

MATERIAL AND METHODS

The species of the family Sididae live in a variety of habitats like ponds, man-made reservoirs, marshes and rice fields. With suitable plankton nets the samples were collected among vegetation and close to the bottom of shallow water bodies and marshes. Oblique hauls were taken to obtain zooplankton samples from the shores of man-made reservoirs and ponds. The samples collected from the field were preserved in 5% and 10% formalin with sugar and stored in plastic containers for further study. Measurements of body size, head and carapace were made with a calibrated ocular micrometer using a compound microscope.

RESULTS AND DISCUSSION

Latonopsis australis Sars, 1888 (Fig. 1)

Measurements: Body size: female 1.70 mm; male 0.71 mm.

Occurrence: Several females and males in marshy ponds, man-made reservoirs and rice fields of Madurai, Madras, Ramnad, Tirunelveli, Tanjore and Kanyakumari.

FEMALE: Head large with antennule on the ventral side. Eye large, situated very near to anterior margin of the head; ocellus conspicuous; setae on antenna: 4-7/0-1-4. Ventral margin ornamented with rows of long hairs at the anterior side, medium hairs at the middle and three long setae at the posteroventral corner. Postabdomen broad with two spines at the base of the claws, anal denticles 10-12.

MALE: Antennule long; eye shifted to the dorsal side; postabdomen with two long sperm ducts.

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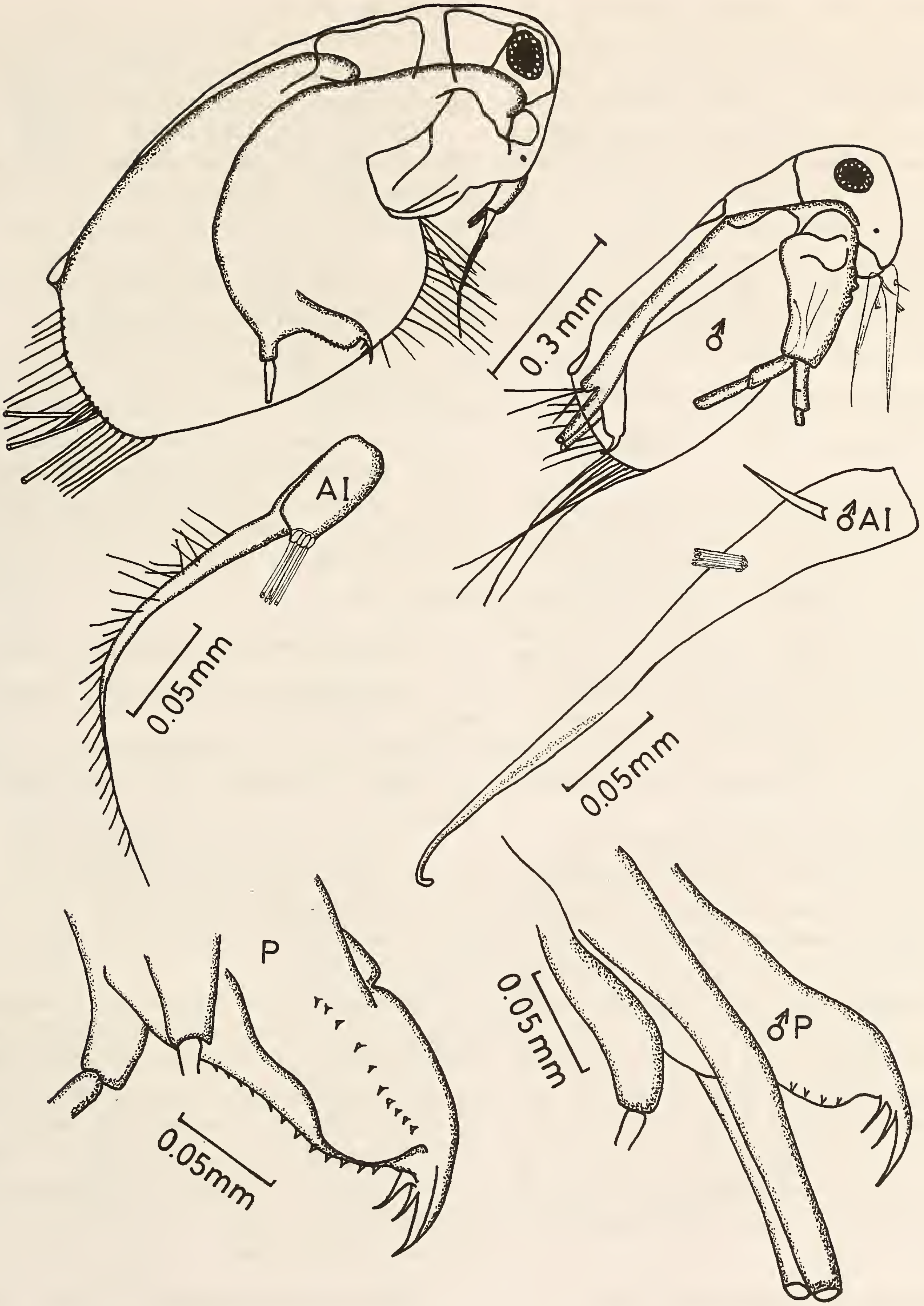
0.3 mm
♂
AI
♂AI
0.05mm
0.05mm
P
♂P
0.05mm
0.05mm

Fig. 1. *Latonopsis australis,* female and male.
P = post-abdomen, AI = antennule.

L. australis was originally described from Australia. It was redescribed by Sieh-chih and Nan-shan (1979). After examining a number of important characters like total margin of the shell spines and the spines on the lateral sides of the postabdomen, Harding and Petkovski (1963) concluded that *L. australis* was the only valid name and all the other described species like *L. occidentalis* Bridge, *L. breviremis* Daday, *L. ferganica* Mukhamediev and *L. kokubai* were synonyms. This is the first record of the occurrence of this species in south India.

Pseudosida bidentata Herrick, 1884 (Fig. 2)

Measurements: Mean length, female 2.00 mm.

Occurrence: Several females in marshy ponds and rice fields at Madras, Madurai, Ramnad, Tirunelveli, Tanjore and Kanyakumari.

FEMALE: Cervical sinus present. Antennules attached at the sides of the rostrum. Setae on antenna: 5-10/0-1-3. Anteroventral corner of the carapace fringed with long hairs followed by small spines. Postabdomen with medium projection on dorsal side near the apex; 10-14 anal denticles present on the lateral side; claw with two basal spines.

Ephippium round without leathery coat.

Thomas (1961) reviewed the validity of the name *P. bidentata* and provided evidence that the species name *bidentata* should be retained. The character that differentiates *P. bidentata* and *P. szalayi* is a spine-like projection on the distal margin of the postabdomen. The visibility of this projection on the dorsal side lies only in the method of preservation. Thomas (1961) suggested that the projection could be seen clearly in specimens well preserved in formalin. In the present investigation also this was so. This is the first record of the occurrence of this species in south India.

Diaphanosoma excisum Sars, 1885
(Fig. 3)

Measurements: Body size: female 1.20 mm; male 0.98 mm.

Occurrence: Several females and males in reddish-brown ponds at Madurai, Coimbatore, Tiruchi, Tanjore, Tirunelveli and Ramnad.

FEMALE: Head one-third of total length, rostrum absent, cervical sinus well marked. Antennules small, situated at the ventral side. Eye small, without ocellus. Carapace oblong-oval in shape, truncate at the posterior end. Posteroventral corner with six to nine denticles. Ephippium round without leathery coat.

MALE: Smaller in size than female, with long antennule. Postabdomen with two long sperm ducts. First leg modified into a hook.

D. excisum is a distinctly dominant species in the limnetic regions of Tamil Nadu as observed in other tropical regions like Sri Lanka, South-East Asia (Fernando 1980). This is the first record of the occurrence of this species in south India.

Diaphanosoma sarsi Richard, 1894 (Fig. 4)

Measurements: Body size, female 1.25 mm.

Occurrence: Several females in irrigation reservoirs and marshy ponds throughout Tamil Nadu.

FEMALE: Eye large, fills the head almost completely. Long setae on margin of ventral fold. Posteroventral corner with 17-23 spines. Postabdomen with characteristic setae on the lateral side.

Harding (1957) considered *D. singhalense* Daday to be a synonym of *D. sarsi.* Dumont and Van de Velde (1977) found a slightly different type of armature on the posteroventral corner in *D. sarsi* at Nepal. However, the present study reveals that the material collected from Madurai resembles the description of Harding (1957). This is the first record of the occurrence of this species in south India.

Diaphanosoma senegalensis (Gauthier, 1951)
(Fig. 5)

Measurements: Body size, female 2.00 mm.

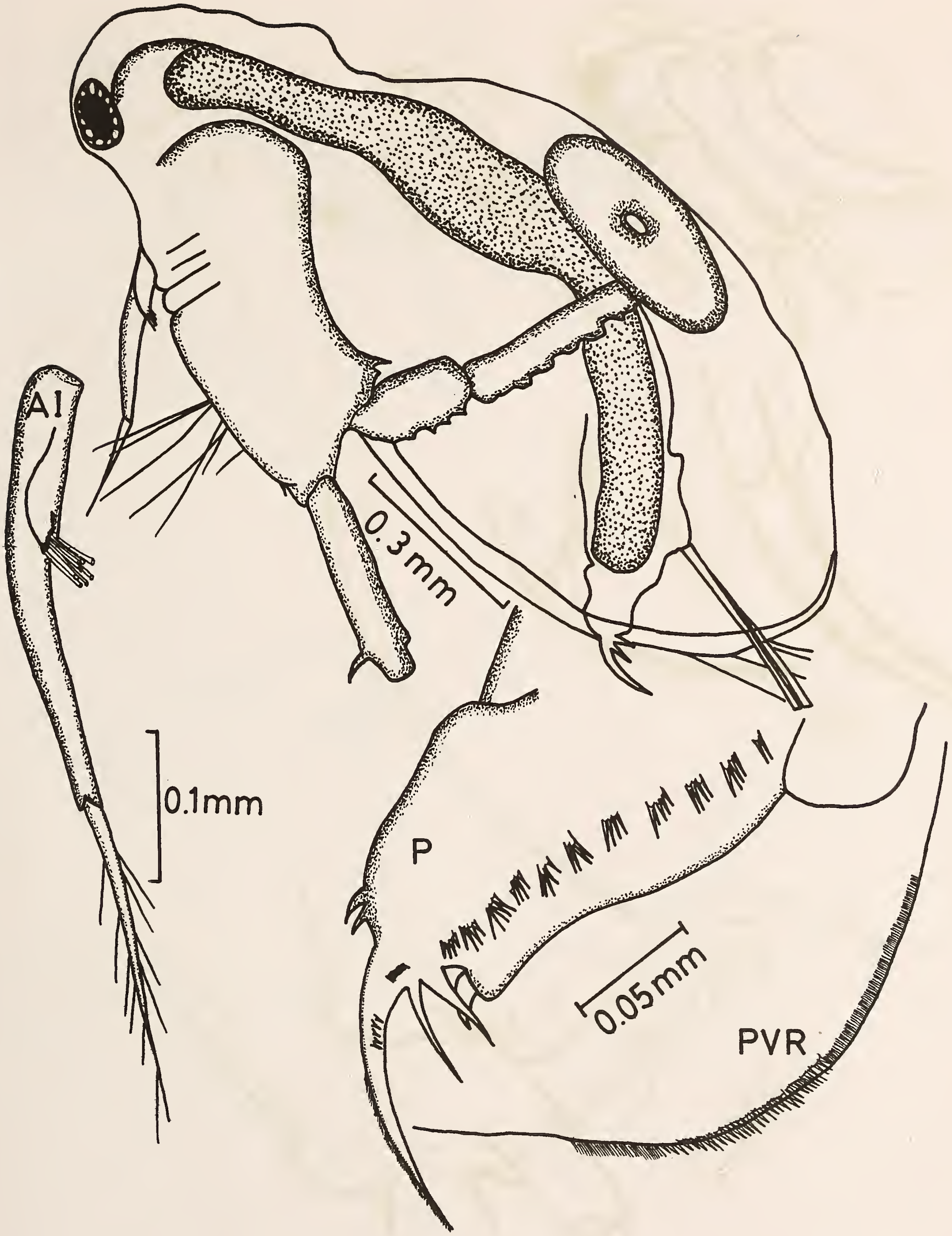
AI
0.3 mm
0.1mm
P
0.05mm
PVR

Fig. 2. *Pseudosida bidentata*, female.
P = post-abdomen, PVR = posteroventral corner, AI = antennule.

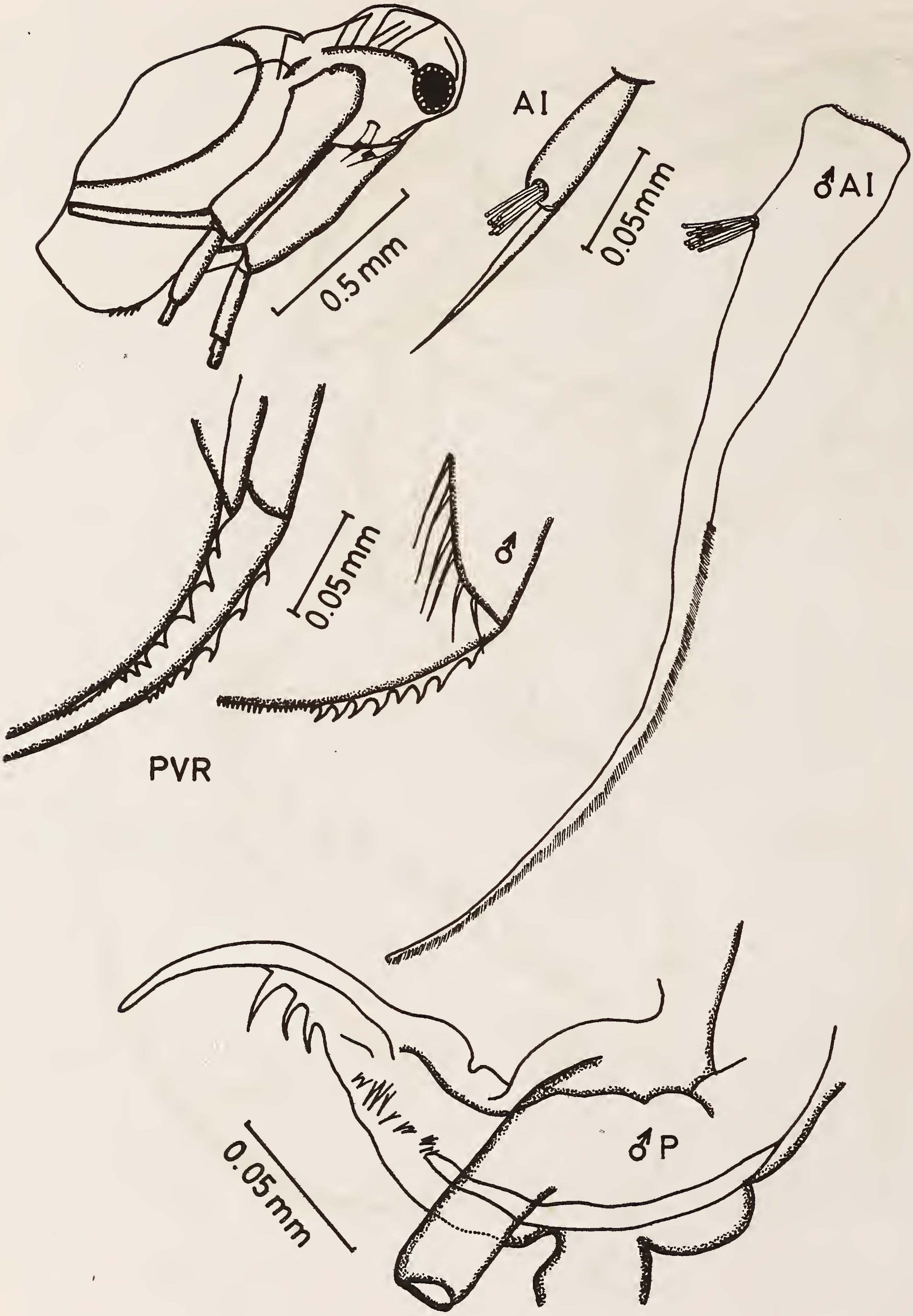
AI
0.05mm
0.5 mm
♂AI
0.05mm
♂
PVR
♂P
0.05mm

Fig. 3. *Diaphanosoma excisum,* female and male.
P = post-abdomen, PVR = posteroventral corner, AI = antennule.

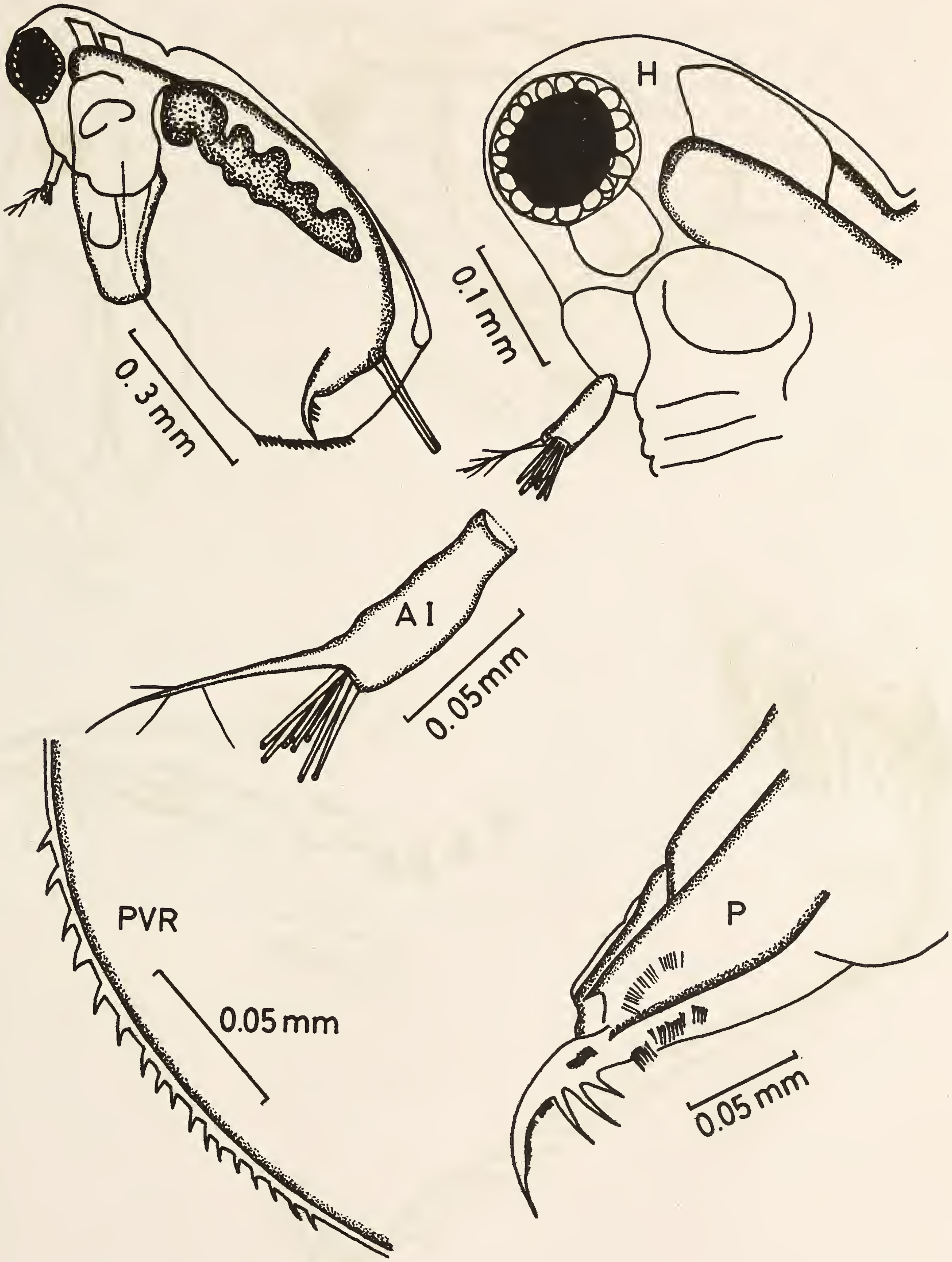
H
0.1 mm
0.3 mm
AI
0.05 mm
PVR
0.05 mm
P
0.05 mm

Fig. 4. *Diaphanosoma sarsi,* female.
P = post-abdomen, PVR = posteroventral corner, AI = antennule, H = head.

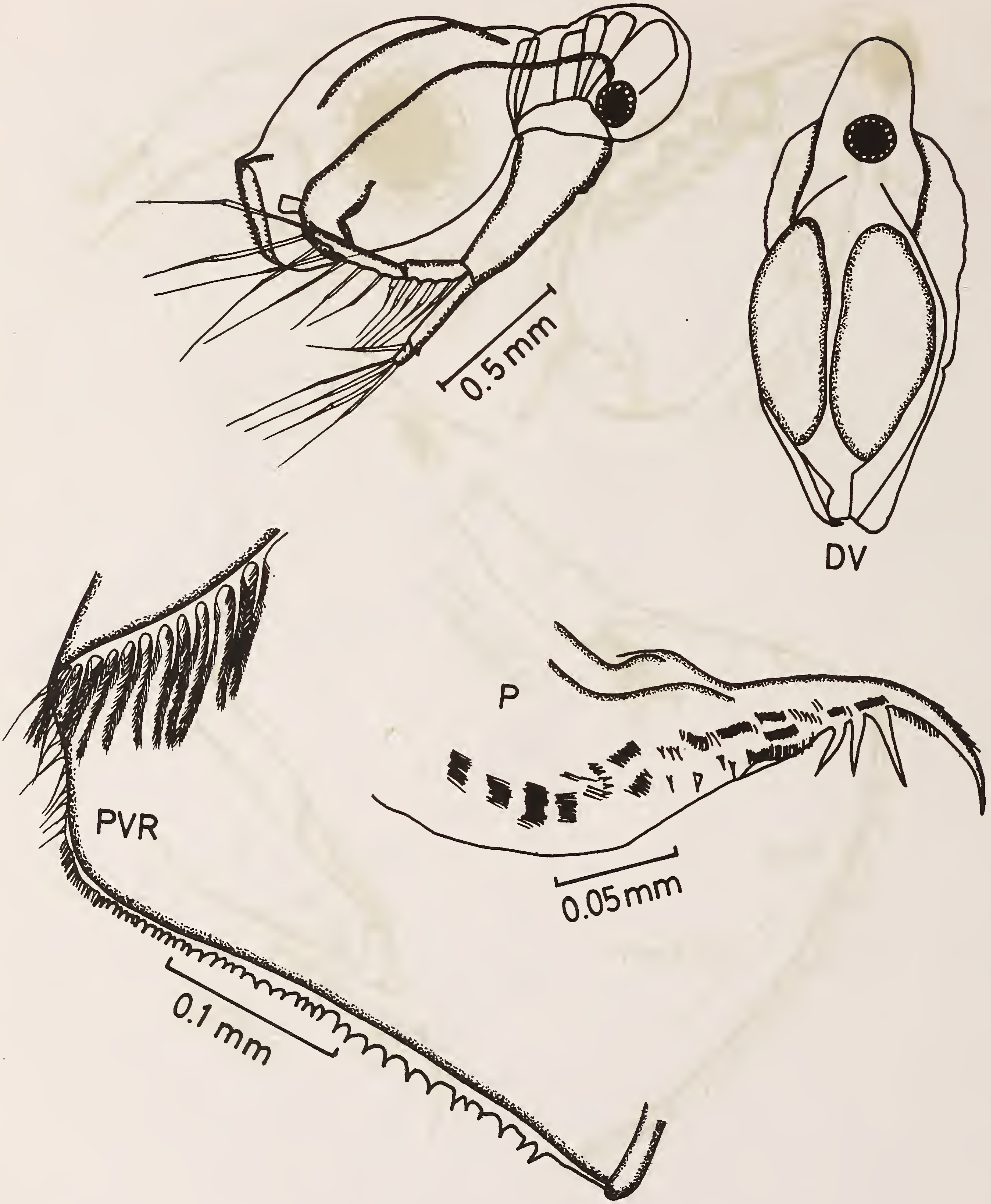
0.5 mm
DV
P
PVR
0.05mm
0.1 mm

Fig. 5. *Diaphanosoma senegalensis*, female.
P = post-abdomen, PVR = posteroventral corner, DV = dorsal view.

Occurrence: Several females in reddish-brown ponds of Madurai, Madras, Tiruchi, Tirunelveli and Ramnad.

FEMALE: Length greater than height; supraocular depression less prominent, dorsal margin hump-backed, brood pouch superior to cephalic margin. Setae on antenna: 4-8/0-1-4; spines: 1-1/0-1-1. Postabdomen tapering at the distal region, dorsal margin straight with groups of prominent denticles and groups of lateral setae; claw with three long basal spines which increase in length towards distal end with seta on the ventral distal and concave margin.

Venkataraman and Krishnaswamy (1984) have recorded this species from Madurai with a brief description. The same authors have amended the original name *D. senegal* to *D. senegalensis*

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NEST SITE SELECTION BY CAVITY-NESTING BIRDS ON *MELIA AZEDARACH* L. AND MANAGEMENT OF MULTIPLE USE FORESTS[1]

Deep Narayan Pandey[2] and Dhananjai Mohan[3]

Key words: cavity nesters, *Fomes*, heart-rot fungi, *Melia azedarach*.

Nest site selection by cavity nesting birds on *Melia azedarach* L. was studied at New Forest, Dehra Dun. Four species of birds are primary cavity nesters and six species secondary cavity nesters. Live trees of higher girth, infected with heart-rot fungi (*Fomes* spp.), are the most preferred for cavity excavations. We suggest retention of such potential nest trees in multiple use forests and planting of *Melia azedarach* in recreation and multiple use plantations where part of the crop is retained till its natural lease of life.

Introduction

Numerous bird species, especially cavity nesters, depend upon trees for suitable roosting and nesting sites. Maintenance of cavity-nesting bird populations depends upon the silvicultural systems and forest management practices in vogue. If avian use of the trees of particular species in a forest site can be associated with easily measured variables, suitable conservation and management strategies for cavity-nesting birds can be evolved and incorporated into management principles for multiple use forests.

A comparative study of different species of birds using one tree species for cavity-nesting is not easily available. The study on the use of *Melia azedarach* L. by cavity-nesting birds is first of its kind in India. We evaluated the utility of *Melia azedarach* L. trees to cavity-nesting birds at New Forest, Dehra Dun, with the objectives of describing and quantifying important characteristics of nest trees and the stand surrounding the nest trees used by cavity-nesters.

Study area

New Forest, Dehra Dun is situated at 30° 20′ 40" N, 77° 52′ 12" E. Altitude is 640.08 m. Average values of meteorological data for 10 years (1979 to 1988) are as follows: annual rainfall 1818.9 mm, minimum temperature 13.5°C, maximum temperature 28.1°C, mean temperature 20.3°C and relative humidity 79%. New Forest is situated in the middle of the Dun valley and is bounded by the Tons river valley to the north and west. Adjoining Tons river valley are degraded sal *Shorea robusta* forests and heavily lopped trees. New Forest encompasses lawns and gardens, buildings, log-pond, canal, variety of flowering and fruiting trees, experimental forests and plantations, providing suitable habitat for 214 species of birds (George 1957).

Methods

The entire study site was searched for the *Melia azedarach* L. active nest trees from February 1989 to July 1990, and then for a brief period in June 1991. Nests were located by auditory and visual cues. The following information was recorded for each active nest tree: date found, height of nest opening, tree height, girth at breast-height, basal area of live trees surrounding the nest tree, status of trees (*snag* – intact or broken top: *live* – broken top; *intact* – dead or intact live top) and information on presence of heart-rot fungi.

Nesting cavities were identified with 8x30 and 12x50 binoculars. A Haga altimeter was used to determine height, and wedge prisms (with basal area factor 3,5,6 and 7) were used to

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determine the wood basal area of the plantations and forests around nest trees.

Pearson product moment correlation coefficient was used to examine the extent of relationship between nest height and tree height. Regression equation of nest height (x) on tree height (y) was also calculated. The t-test was used to ascertain whether or not mean nest height differed significantly between primary and secondary cavity nesters.

RESULTS

In *Melia azedarach* trees, four species of birds are primary cavity-nesters and six species secondary cavity-nesters (Table 1). Primary cavity-nesters are species capable of excavating their own nest, while secondary cavity-nesters either re-use the cavities excavated by primary cavity-nesters or are dependent on natural holes and cavities (Ali and Ripley 1987, Panicker 1980, Balda 1975).

The nests in the sample for primary cavity-nesters were 5.1 m above the ground ($\bar{X}_1$ = 8.675 m, S.D. = 3.3319) and for secondary cavity-nesters 4.3 m above the ground ($\bar{X}_2$ = 6.6833 m, S.D. = 1.7053). The correlation coefficient (r) between nest height (x) and tree height (y) for primary cavity-nesters (r_1) was 0.7681, for secondary cavity-nesters (r_2) 0.5904; and for cavity-nesters as a whole (r) was 0.6346. Thus, correlation between nest height and tree height is stronger in case of primary-cavity nesters than for secondary cavity-nesters. Since the mean nest heights for primary and secondary cavity-nesters do not differ significantly ($P \leq 0.8$) a single regression line of nest height (x) on tree height (y) will suffice : $x = 0.827\ y - 4.2512$. Mean girth at breast height (gbh was measured at 1.37 m height on the tree trunk) of nest trees was 1.984 m. Mean gbh of primary nest trees ($\bar{X}$ = 1.935 m) was not markedly different from mean gbh of secondary nest trees ($\bar{X}$ = 2.01667 m), for normally the same trees may be used for nesting by primary and secondary cavity-nesters.

Basal area of the forest stand surrounding the nest trees varied from 0.02 sq. m/ha to 39 sq. m/ha.

DISCUSSION

Nesting on live trees and snags: We found that primary cavity-nesters excavated their nest on live trees (97%) infected with heart-rot. These nest cavities along with other natural hollows were re-used by the secondary cavity-nesters. As seen from Table 2, snags form only 3% of nest trees and are not preferred for cavity-

TABLE 1

CAVITY-NESTING BIRDS ON *Melia azedarach* L. AT NEW FOREST, DEHRA DUN

Species of birds		Number of nest trees	Number of nests	Mean nest tree characteristics		
				Nest height (m)	Tree height (m)	Girth at breast height (m)
Primary cavity-nesters						
Dinopium benghalense L.	Goldenbacked woodpecker	2	2	5.3	13.5	2.7
Megalaima zeylanica (Gmelin)	Large green barbet	24	24	7.3	14.2	1.9
Psittacula cyanocephala (L.)	Blossomheaded parakeet	11	14	7.9	11.2	1.9
Psittacula eupatria (L.)	Alexandrine parakeet	1	1	14.2	17.6	1.2
Secondary cavity-nesters						
Acridotheres fuscus (Wagler)	Jungle myna	11	11	5.9	13.2	2.1
Acridotheres tristis (L.)	Common myna	19	24	8.1	18.1	1.8
Copsychus saularis (L.)	Magpie robin	2	2	4.7	13.2	1.6
Pisttacula krameri (Scopoli)	Roseringed parakeet	3	8	9.7	14.5	2.3
Sturnus pagodarum (Gmelin)	Brahminy myna	10	11	5.4	12.3	2.1
Sturnus malabaricus (Gmelin)	Greyheaded myna	14	19	6.3	14.0	2.2

TABLE 2
NUMBER OF CAVITY-NEST TREES (*Melia azedarach* L.) IN EACH STATUS CATEGORY AT NEW FOREST, DEHRA DUN

Status Description	Nest trees Absolute number	Percent of total	Infection of heart-rot Number of infected nest trees	Percent of total
Snag				
Intact top	0	0	0	0
Broken top	1	3.13	1	3.13
Live				
Broken top	18	56.25	18	56.25
Intact dead-top	7	21.87	7	21.87
Intact live-top	6	18.75	6	18.75

nesting. However, most of the studies in U.S.A. report the use of snags as most preferred site for nest excavation (Brush *et al.* 1983, Bull and Meslow 1977, McClelland and Frissell 1975, Raphael and White 1984, Scott 1979, Dickson *et al.* 1983).

Fungal infection on nest trees: Nesting in the trees infected with heart-rot fungi appears to be the general rule for primary cavity-nesting birds (Table 2). In an earlier paper we reported the presence of *Fomes senex*, *F. fastuosus* and *F. caryophylli* fungi causing heart-rot, in *Melia azedarach* nest trees (Pandey and Mohan 1989). Though such studies are rarely available in India, many workers from abroad like Conner *et al.* (1976), Shigo and Kilham (1968), Milne and Hejl (1989), Swallow *et al.* (1986) and Heald (1933) have reported the presence of heart-rot and decay fungi on nesting trees.

Suggested forest management strategy: Based upon the study it can be concluded that live *Melia azedarach* trees of higher girth classes, with broken or intact top, and infected with heart-rot fungi, are the most suitable for many species of cavity-nesting birds. Our results provide qualitative and quantitative criteria for management of multiple use forests favouring the cavity-nesting birds. In India most of the production forests aim at achieving sustained yield in perpetuity. Working plans for the management of forests prescribe the removal of all dead, dying, diseased and silviculturally available trees during the silvicultural thinnings, with a view to improve the sanitation of the forests. Working plans also prescribe harvesting of trees above the exploitable diameter or above the rotation age to get a sustained yield. (Misra 1969, Jayaraman 1974, Prakash and Khanna 1979).

Though we agree with the necessity to improve the sanitation of production forests in order to obtain quality timber and to save natural forests from pests, we feel that foresters should recognise and evaluate the impact of removal of dead, dying and diseased trees on the cavity-nesting birds, which are voracious insect-eaters and can thus be an effective biological control against insect-pest epidemics in the forests. We suggest that studies should be conducted to examine our proposal of retention of dead, dying and diseased tree-bearing multiple use woodlands, as is being practised in some biosphere reserves, national parks, sanctuaries and protected areas. This will be a viable management strategy for cavity-nesters outside the protected areas. Depending upon the vulnerability of a forest-type to insect-pest epidemic and the degree to which a management plan favours cavity-nesting birds, a better guideline for retention of potential nest trees can be developed specifying the number/ha, species and minimum diameter at breast-height. Such studies in the Indian context are totally lacking.

We also recommend that *Melia azedarach* be planted in polyculture plantations under recreation and multiple use forestry, such as roadside avenues, wind breaks and shelter belts; and should be retained as potential nest trees based on the principles of physical rotations, i.e. till the natural lease of life.

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CELLULOSE-DEGRADING FUNGI AROUND BOMBAY[1]

R.G. BAGOOL[2]

Key words: cellulose degradation, *Chaetomium*, fungi, *Microascus*.

In a study of cellulose-degrading fungi around Bombay, six ascomycetous forms, namely *Chaetomium atrobrunneum, C. cymbiforme, C. funicolum, C. globosum, Microascus cinereus* and *M. cirrosus* were isolated from cellulosic materials like cloth and different kinds of papers. *C. atrobrunneum* is a new record for India while *C. funicolum* and *M. cinercus* are being reported for the first time from Maharashtra. These isolates were also tested for their cellulolytic activity in terms of loss in weight of filter paper. *C. funicolum* produced maximum loss in weight (54.30 mg) in seven days, while *M. cirrosus* produced minimum loss in weight (17.46 mg). *M. cinereus* failed to produce any loss in weight and hence it seems to be non-cellulolytic.

INTRODUCTION

Cellulose degradation helps in maintaining the carbon cycle in nature. It is one of the obvious activities of micro- organisms, chiefly fungi. Although many fungi live on different cellulosic articles like fabric and paper, a few of them have the ability to degrade cellulose. As a result, there are adverse effects on the quality of the articles, such as discolouration, loss of lustre, loss in weight and loss in tensile strength.

The loss in weight is a very popular method for quantitative determination of cellulolytic activity. Basu and Ghose (1962), Fergus (1969) and Park (1976) have employed the loss in weight method to study cellulolytic activities in different fungi and actinomycetes. However, as they have used different organisms, culture media and incubation periods the results are not comparable.

MATERIAL AND METHODS

Isolation of the fungal forms: These fungal forms were clearly visible in the form of their perithecia on the cellulosic articles and could hence be easily isolated on PDA. Subcultures were maintained on PDA only with adequate amount of streptopenicillin as antibacterial agent. These forms were identified using standard methods and were sent to CAB Mycological Institute (CMI-U.K.) for confirmation of identification.

Loss in weight and activity of isolates: Three-week-old cultures grown on PDA slants (pH 5.5) were used as inoculum. A spore suspension was made by mixing the three-week-old colony with 10 ml sterile distilled water. A loopful of the suspension was then added to each of the sterile petri dishes each containing two pre-weighed circles of Whatman filter paper No. 1 (9 cm diameter) and 20 ml of *T. viride* medium (pH 5.5) (Sternberg 1976).

The plates were incubated at room temperature (average mean temperature 27°C ± 1°C) for seven days. At the end of the incubation period the filter papers along with the mycelium were dried in an oven at 60°C for 48 hours and weighed on a single pan balance.

The difference in weight of each doublet of the filter papers was calculated by comparing the final weight with initial weight. If the final weight of the filter paper was more than the initial weight the fungus was considered to be non-cellulolytic. In such cases, the increase in weight was attributed to the production of mycelium utilizing peptone and also adsorption of materials from liquid medium by the paper. This was recorded as zero loss in weight. Those cases where the filter paper plus mycelium weighed less than the initial weight of the filter paper, the

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fungus was considered to be cellulolytic in nature and the net loss in weight was attributed to the non-recoverable products of cellulose degradation, and was recorded as loss in weight of the filter paper.

RESULTS AND DISCUSSION

TAXONOMIC STUDIES

The following are some of the ascomycetous forms isolated from the mildewed cellulosic articles.

Chaetomium atrobrunneum Ames

(Mycologia 41:641. 1949) IMI No. 308990.

Isolated from sized cloth collected at Bombay. *C. atrobrunneum* is being reported for the first time from India.

C. cymbiforme Lodha

(J. Ind. Bot. Soc. 43: 121-120. 1963) IMI No. 318414.

Isolated from non-glazed printing paper collected at Dombivli, Bombay. The isolate has more or less sub-globose perithecia admeasuring 110-150 x 100-110 µm.

Lodha (1963) isolated this species from cowdung at Mount Abu, Rajasthan. Earlier Bagool and Wani (1986) have reported this species on raw cotton from Kopargaon (Maharashtra).

C. funicolum Cooke

(Grevillea, 176. 1873) IMI No. 318396.

Isolated from non-glazed printing paper collected at Bombay. *C. funicolum* has been isolated quite frequently from various organic substrates such as dung of different animals, soil, paper, fibre, stored grains etc. (Bilgrami *et al.* 1979, Sarbhoy *et al.* 1986). Bilgrami (1963) has reported this species as a pathogen on ornamental plants. This species is being reported for the first time from Maharashtra.

Chaetomium globosum Kunze ex Fries

(Syst. Mycol 3: 225. 1829) IMI No. 334358.

Isolated from non-glazed printing paper collected at Bombay. The species is very frequently isolated from various organic substrates from different parts of the world (Seth 1970, Bilgrami *et al.* 1979, Sarbhoy *et al.* 1986). Siu (1951) has listed this species as strongly cellulolytic. This species is being used as a test organism for testing fabrics for resistance to mildew (Marsh *et al.* 1945).

Microascus cinereus
(Emile-Weil & Gaudin) Curzi

(Boll staz patol. vegetale, Roma 11:60.1931). (Syn. *Scopulariopsis cinerea* Emile-Weil and Gaudin Archiv. med. exptl. anal. pathd. Paris 28: 452-467. 1919) IMI No. 308985.

Isolated from sized cloth collected at Bombay. There are very few Indian records of this species. All of them report this species as a pathogen of various plant parts (Bilgrami *et al.* 1979, Sarbhoy *et al.* 1986). This species has not been earlier reported from Maharashtra.

M. cirrosus Curzi

(Bull. staz, patol. vegetale, Roma 10: 302-10. 1930) IMI No. 334364.

Isolated from damaged cotton of a mattress collected at Dombivli (Bombay).

Sattar and Hussain (1979) have observed this species as a pathogen on cauliflower leaves. Earlier, it has been reported on raw cotton collected at Kopargaon (Maharashtra) by Bagool and Wani (1986).

Cellulose degradation: Table 1 depicts the cellulolytic activities of the six ascomycetous forms in terms of loss in weight of the filter paper in seven days of incubation (increase in weight is considered as a zero loss in weight).

From Table 1 it is evident that out of the six isolates, *C. funicolum* has the maximum cellulolytic activity in terms of loss in weight, followed by *C. atrobrunneum*, *C. globosum*, *C. cymbiforme* and *M. cirrosus*. On the other hand, *M. cinereus* failed to degrade filter paper.

TABLE 1
CELLULOLYTIC ACTIVITY IN SIX FUNGAL ISOLATES MEASURED AS LOSS IN WEIGHT OF FILTER PAPER AFTER SEVEN DAYS

Organism	IMI No.	Initial weight of filter paper (in g)	Loss in weight (in mg)*
Microascus cinereus	308985	1.09785	zero
M. cirrosus	334364	1.10700	17.46
Chaetomium atrobrunneum	308990	1.11256	25.35
C. cymbiforme	318414	1.09203	21.03
C. funicolum	318396	1.11041	54.30
C. globosum	334358	1.11096	44.49

* Mean of the results in triplicate.

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A STUDY ON SOME ASPECTS OF THE BEHAVIOUR OF *CATHARSIUS MOLOSSUS* (L.) AND *C. PITHECIUS* (F.) (COLEOPTERA : SCARABAEIDAE)[1]

K. Veenakumari[2] and G.K. Veeresh[3]

(With a plate and a text-figure)

Key words: *Catharsius molossus, C. pithecius*, brood-balls, feeding, mating, nesting.

The feeding and nesting behaviour of *C. molossus* and *C. pithecius* were studied, the latter for the first time. Mating behaviour of *C. molossus* was observed. The brood balls prepared by the female were found singly in a brood chamber. There was no parental care. Earthworms belonging to *Dichogaster* sp. fed on the dung that made up the brood balls.

Introduction

India, lying in the subtropics, has a rich fauna of dung beetles, especially scarabaeines. Arrow (1931) in his comprehensive work on the Indian Scarabaeinae reported 354 species under four tribes. *Catharsius* is a major genus among the dung buriers and carries a considerable amount of dung into the soil.

Earlier Paulian (1945, in Halffter and Matthews 1966), Walter (1978, 1980), Rougon and Rougon (1980), Aschborn and Bornemizza (in Halffter and Edmonds 1982) had worked on the behaviour of this genus. Mating in *Catharsius dux* Harold has been described by Walter (1978). Halffter and Edmonds (1982) had included *Catharsius* under pattern II of nidification.

In this paper an attempt has been made to study the behaviour of two species of Indian *Catharsius*, viz. *C. molossus* and *C. pithecius*.

Material and Methods

The beetles used for laboratory experiments were collected from pasture land in north Bangalore, south India. In the field the presence of these beetles was evident from the large piles of subsoil in the vicinity of relatively fresh dung pats. The size of the opening of the burrow and the length of the burrow, were measured. The amount of dung that was taken underground was weighed.

To study nesting pattern, glass sheets 5 cm apart were fixed into a three-sided wooden frame with grooves so that the glass sheets could easily be slid into and out of the frame when required for observations. Three-fourths of the cage was filled with moist soil, on top of which a 4-5 cm layer of fresh cowdung was deposited. The required number of beetles were released into the cage and the top was covered with a wire mesh. The entire cage was covered with a black cloth and placed in a dark corner of the laboratory. Periodic observations on various aspects of feeding and nest building were made.

Some beetles were also released into large deal-wood boxes (0.9x0.9x0.9 m), filled with moist soil topped with a layer of fresh dung. The tops were covered with wooden lids. After 10-15 days, one wall of the deal-wood box was opened out and the soil was sliced vertically, to study nest architecture.

Results

Catharsius molossus (L.)

Feeding: The beetles were attracted by cow, elephant, pig and human faeces. The food

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burrows were formed during the initial phase after emergence, and were usually occupied by a single beetle, either a male or a female. The burrows were found right beneath the dung pat and towards its edge. The beetles constructed food burrows by excavating soil using their shovel-like clypeus and broad, spade-like tibiae, loosening the soil by digging with the clypeus and forelegs. Later some soil was scooped out using forelegs and clypeus, and pushed under and behind the beetle. It then took a 180° turn, bulldozed the soil with its clypeus and threw it onto the surface of the soil. This was done several times during the process of tunnel construction. Usually the food burrows were straight to begin with, followed by a segment that slanted downwards.

After thus constructing the tunnel, the beetle returned to the surface where the dung was and separated a fragment of it using its forelegs and clypeus as cutters. It then moved down the tunnel with its rear end first till its abdomen touched the end of the burrow. It then dropped the fragment and climbed over it, took a 180° turn and compacted it against the wall of the burrow using its clypeus and forelegs. In this manner the burrow was partially filled with dung. The average time taken by a beetle to collect a mass of dung of dimensions 2.5x1.1 cm was 20 min. 10 sec. The food masses collected in the field were sausage-shaped (Plate 1A). At times bifurcated food burrows were constructed, with the beetle feeding in both burrows. Burrows that were abandoned after feeding contained dried fibres of dung along with the faecal matter of the beetle.

The average diameter of the entrance hole of the food burrow was 3.63 cm. The mean length and depth of the tunnel were 29.93 and 18.72 cm respectively. The amount of soil excavated was 200 g and the average weight of dung carried by the beetle for food was 94.46 g.

In one instance, two entrance holes 3.5 cm apart led into tunnels of 9.6 cm and 8.1 cm, respectively. These two tunnels later converged and formed a single tunnel up to a distance of 16.8 cm. At the terminal end a female of *C. molossus* was found with 56.2 g of dung, probably collected for brood purposes.

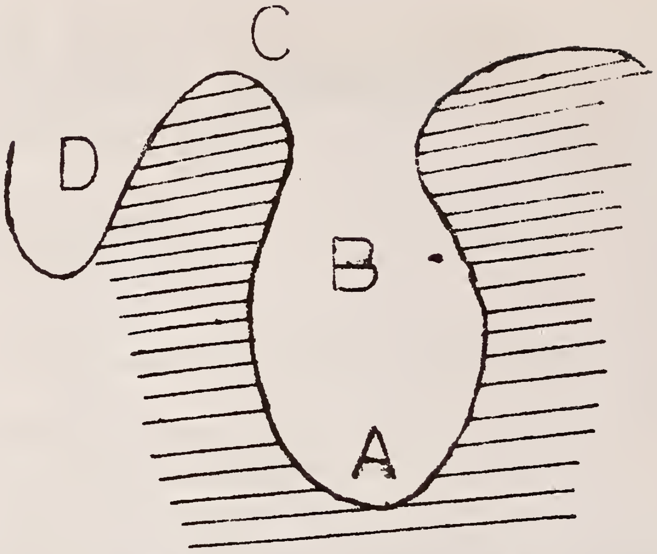
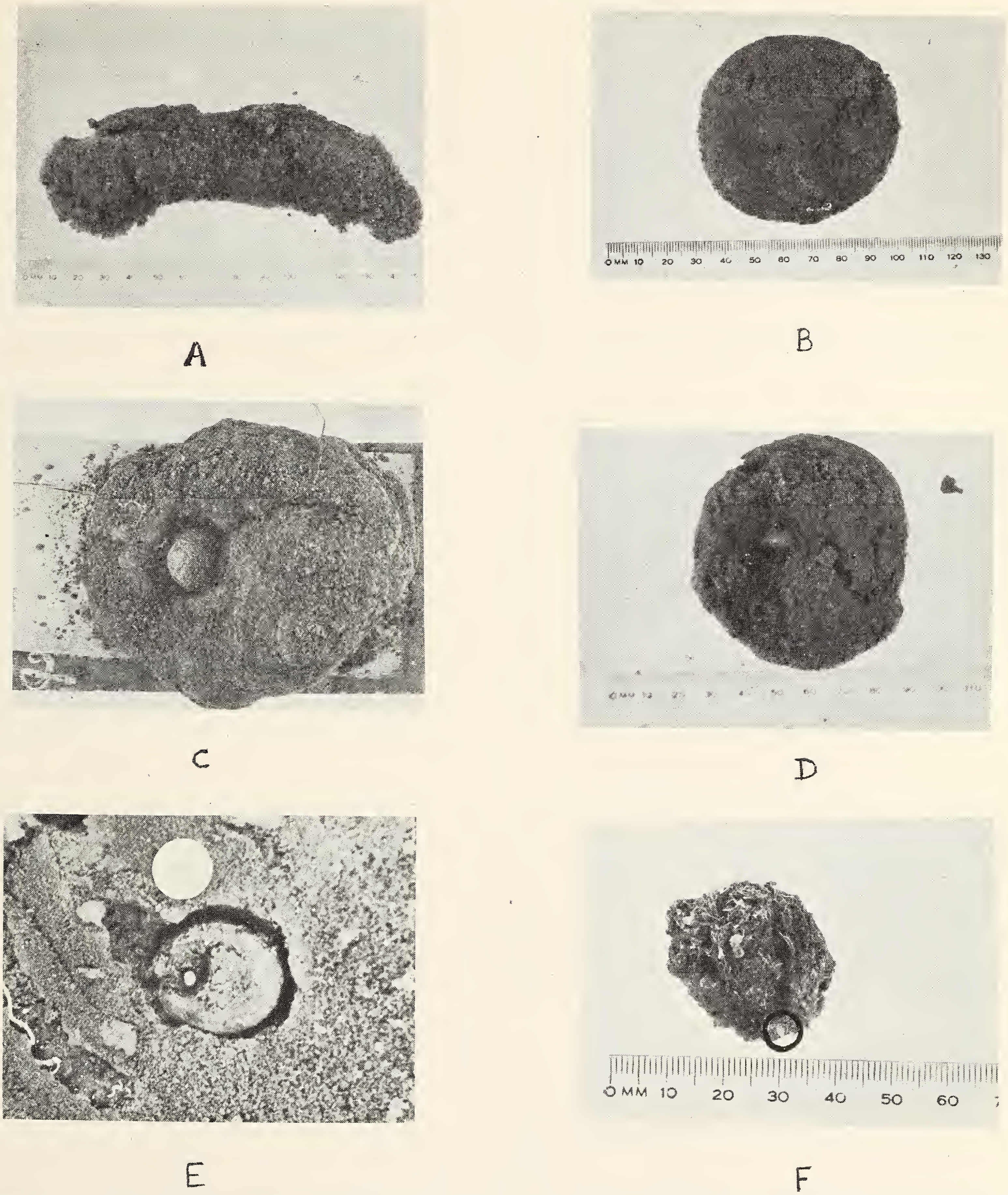


Fig. 1. Regions of burrow occupied by male and female *C. molossus* during mating.

Mating: The male and female that were released in the glass cages constructed their respective food burrows immediately. Four days later they mated, after having gone through the following sequence of acts.

The male was found in region C and female in region B (Fig. 1). Since the male was bigger than the female the male scooped out some soil from region C and placed it in burrow D, making place for itself. It reached the female, and pushed her down to position A, where she rested on the floor of the burrow. The female remained passive during this period. Perhaps finding the place too narrow, the male then scooped some more soil and moved it into burrow D. It was only then that the female became active and went back to the position B, from where she was pushed back. Then both beetles stood facing each other, waving their antennae and maxillae for a few seconds. The male then climbed over the female, held her abdomen with his meso- and metathoracic legs and copulated for 17 min. 35 sec. While mating, both beetles slowly moved their forelegs and antennae.

After mating, the female entered the soil beneath A, excavated some soil and stayed in a


A
B
C
D
E
F
0 MM 10 20 30 40 50 60 70 80 90 100 110 120 130
0 MM 10 20 30 40 50 60

A. Sausage-shaped dung mass of *C. molossus;* B. Brood ball of *C. molossus* with a thick clay coating; C. Brood ball of *C. molossus* in the brood chamber; D. Egg chamber of *C. molossus* coated with soil; E. Brood ball of *C. pithecius* in brood chamber; F. Earthworms (*Dichogaster* sp.) in brood ball of *C. molossus.*

cell, having formed a barrier between the male and herself. The beetles were found in the same position the next day also.

Nesting: Nesting involved cooperation between the male and the female. The female dug a tunnel which was initially vertical but later slanted. The tunnel ended in a brood chamber with a broad end, sufficient for a single brood ball. The male helped the female in provisioning with dung. Once a sufficient quantity of dung was placed, it was converted into a brood ball. Two days after provisioning, the brood ball was found with a thick coating of clay (Plate 1B). By then both parents had abandoned the ball.

Brood balls: These were found at a depth of 44-45 cm except in one case, where it extended to a depth of 90 cm. These balls were present singly in a cell which was slightly bigger than the brood ball (Plate 1C). The brood ball did not touch the walls of the cell.

The brood balls were spheroids with a thick coating of soil. The average thickness of the clay coating was 6.45 mm, and was not uniform but varied from 5.87 to 6.75 mm in thickness. The upper pole of the ball was devoid of clay and had a network of fibres of dimension 0.8x1.11 cm just above the egg chamber. The egg was elongate (1.3x0.9 cm) and stood vertically on its pointed end. The interior of the egg chamber was completely coated with soil (Plate 1D). The brood ball was placed in the brood chamber with the egg chamber occupying the top.

The average length of the brood ball was 6.13 cm and breadth 5.7 cm. The weight varied from 85 to 196 g (av. 122.9 g).

In none of the cases were the parents observed with the brood ball, indicating absence of parental care.

Catharsius pithecius (F.)

This species is smaller than *Catharsius molossus* and was attracted to cow-dung. These beetles also constructed shallow food burrows in which they fed during the 'Reifungsfrass' period.

Nesting: In the glass cages, each female assisted by a male constructed a vertical tunnel which later slanted and ended in a broad brood chamber. Nests were constructed at depths of about 16 cm. In one instance the brood balls were constructed at a distance of 24 cm, but each had a different tunnel leading from the top.

At times the beetles were seen (under field conditions) constructing a long horizontal tunnel 0.9-1.2 m about 1 or 2 cm beneath the soil, which dropped vertically to a depth of 30-40 cm. The female was found at the broad end of the tunnel which was filled with dung. The male stayed in the upper part of the tunnel. Apart from this type of tunnel the female was also seen constructing tunnels similar to those in glass cages.

Brood balls: The brood balls were pear-shaped and had a coating of clay except at the top, which was composed of a fibrous network. The brood balls were constructed at an average depth of 33.6 (18-45) cm. The average length, diameter and weight of the brood balls were 3.42 (3.0-4.2) cm, 2.99 (2.4-3.5) cm and 14.95 (8.0-24.6) g respectively.

The brood chamber was pear-shaped and had the terminal end closed. The ball rested at the bottom of the chamber without touching the sides. The average length and breadth of the brood chamber was 8.0 and 4.8 cm, respectively.

Some of the brood balls were observed to have been attacked by earthworms of the genus *Dichogaster* (Oligochaeta : Megascolecidae : Octo-chaetineae) (Plate 1F). In such brood balls neither eggs nor larvae were present.

DISCUSSION

The fact that *Catharsius* spp. make individual brood balls in separate chambers includes it in pattern II of nidification behaviour, even though its behaviour is very different from other genera belonging to this group (Halffter and Edmonds 1982). The egg chamber is superior as in other species of *Catharsius* (Halffter and Edmonds 1982), with the difference that the egg chamber was coated with clay.

Unlike other species of *Catharsius* (such as *C. ulysses* Boheman, *C. harpagus* Harold and *Catharsius* sp. nov. near *pandion* Harold), *C. pithecius* and *C. molossus* do not make a double tunnel for providing dung prior to brood ball preparation. The provisioning is very similar to *Copris repertus* (Veenakumari and Veeresh, unpublished) where the brood chamber is filled directly without provisioning in any other chamber prior to ball making. Brood balls of *C. molossus* were coated with a layer of soil (6.45 mm). This is in contrast to Ashborn and Bornemizza's (in Halffter and Edmonds 1982) observation that *C. molossus* brood balls do not have a soil coating.

ACKNOWLEDGEMENTS

We are grateful to Dr. R. Madge, British Museum (Natural History) for identifying the beetles and to Dr. (Mrs.) Radhakale, University of Agricultural Sciences, Bangalore, for identifying the earthworms. Our sincere thanks are due to Prashanth Mohanraj for having gone through the manuscript.

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NEW DESCRIPTIONS

A NEW *PHYLLANTHUS* L. (EUPHORBIACEAE) FROM NORTH ANDAMAN ISLAND[1]

T. Chakrabarty and M. Gangopadhyay[2]

(With a text-figure)

Phyllanthus sanjappae sp. nov.

Phyllanthus clarkei Hook. f. proxime affinis, sed differt ramulis glabris, foliis sessilibus, ad apicem mucronulatis, stylis ad basin connatis in una columna, *Holotypus: M. Sanjappa* 1 (CAL); Isotypi in CAL.

Closely related to *Phyllanthus clarkei* Hook. f. but distinct in the glabrous branchlets, the sessile leaves, mucronulate at apex and the styles connate at base into a column.

Densely branched shrub, 1-1.5 m high; entirely glabrous; bark fissured; branches brown to greyish, 2-5 mm thick, somewhat angled; leaf-bearing branchlets dark brown, slender, 0.5-1 mm thick. *Leaves* closely distichous, sessile, cuneate-obovate to rhombate-obovate, 8-20 x 4-11 mm, more or less cuneate at base, entire and narrowly revolute along margins, mucronulate at apex, coriaceous, dark brown above when dry, pale green beneath; midrib slender, faint above, prominent beneath; lateral nerves slender, faint, 3-4 pairs, ascending, more or less straight, vanishing near margins; nervules obscure.

Male flowers: not seen. *Female flowers:* axillary, solitary; pedicels 2-3 mm long, 0.8-1 mm thick towards apex, *c.* 0.2 mm thick towards base; sepals six, oblong or broadly ovate-elliptic to oblong-elliptic, 1.5-2 x 0.8-1.2 mm, membranous along margins, rounded to obtuse at apex, disk cupular-annular, crenate, 1.2-1.5 mm diameter; ovary subglobose, *c.* 1 mm diameter, glabrous; styles three, 1-1.2 mm long, connate below into a column (*c.* 0.5 mm long), bifid to quadrifid and recurved above. *Capsules* not seen; persistent central column *c.* 2.5 mm long; fruiting pedicels 5-6 mm long (Fig. 1).

Distribution: INDIA: North Andaman island. Saddle Peak Range, Lamia Bay slope, 7 April 1987, *M. Sanjappa* 1 (CAL – holotype; Isotypes in CAL).

Ecology: Scarce. On dry hill slopes at about 700 m altitude.

As specific distinctions in *Phyllanthus* are usually narrow, the above differences are perhaps sufficient to warrant treating the Andamans plant as a new species. According to Airy Shaw (*Kew Bull. 26:* 317, 1972), *P. clarkei* is a moderately variable species, the variations mostly being the result of ecological conditions, particularly extreme altitude or exposure. However, the branchlets of *P. clarkei* are always minutely papillose-scaberulous on the angles, the leaves are petiolate and rounded to retuse at apex and the styles are free, not as in *P. sanjappae.*

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[1] Accepted February 1992.

[2] Central National Herbarium, Botanical Survey of India, Howrah 711103.

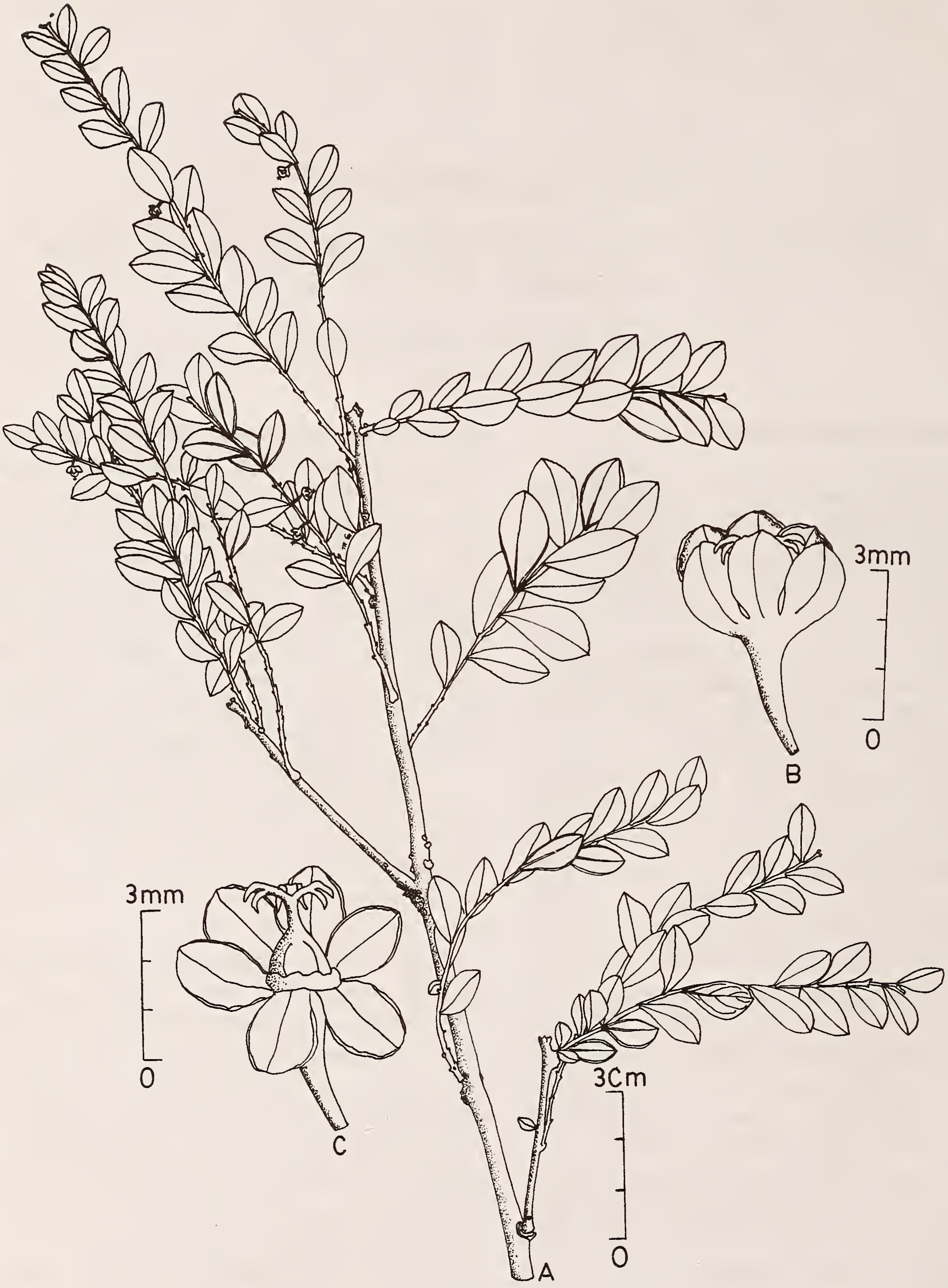
3mm
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Fig. 1. *Phyllanthus sanjappae* sp. nov.
A. Twig with flowers; B. Female flowers; C. Gynoecium with disk.

A NEW SPECIES OF *BULBOPHYLLUM* THOUARS (ORCHIDACEAE) FROM SIKKIM[1]

S.Z. Lucksom[2]

(With eleven text-figures)

During a floristic survey of North Sikkim in July 1990, I came across at Lachung an interesting orchid of temperate region, growing on the rocky slopes. The same species was recollected from the sub-tropical region of Phyangla Reserve Forest in August 1991. On critical examination, this was found to be a new species of *Bulbophyllum* Thouars. It is described and illustrated.

Bulbophyllum flavida sp. nov.

Bulbophyllum triste Rehb. f. affinis sed differt Rhizome breve, 0.5-1.0 x 0.3-0.4 cm. Pseudobulbous 2.5-3.5 x 1.6-2.7 cm. Ovalis. Folia 15-21.6 x 4.8-5.5 cm. Oblong-oblanceolata, acuta. Inflorescentia 14.5-21.5 cm longa, pedunculus 10.5-15 cm longus, teres laevis, bractentus: racemus 4-6.5 longus, parum decurvatus, floribus densis, brevi-pedicellatis. Flores 0.56-0.6 cm longi, aurantiaco-flavi. Sepala inaequales, leviter lutea, 3-nerves, sepalum dorsale 0.47-0.49 x 0.28-0.29 cm, obtusum, oaribus lateralis 0.56-0.57 x 0.3-0.32 cm carnosis crassisoue. Petala *c.* 0.3x0.12 cm, translucence, alba, obtusa. Labellum *c.* 0.3 x 0.13 cm, oblongo-ovatum. Parum deflexum ad medium. Columna *c.* 0.29 cm longa, pes *c.* 0.15 cm longus.

Bulbophyllum flavida sp. nov.

Epilithic. Pseudobulb 2.5-3.5 x 1.6-2.7 cm, oval, broadly ridged, young ones are covered with fibrous sheaths, borne on *c.* 0.3-0.4 cm diameter, stout rhizome at intervals of 0.5-1.0 cm. Roots hairy. Leaves two, 15-21.6 x 4.8-5.5 cm, flaccid, oblong-oblanceolate, tapering to the acute apex and to the sessile base. Inflorescence one, 14.5-21.5 cm long arising from the base of pseudobulb; the peduncle 10.5-15.0 cm long, erect, smooth, terete, the base is covered with crowded imbricate sheaths at base, with 4-5 nodes and internodes. Each node is with 1.5-2 cm long tubular, acute, sheathing bracts; the raceme is 4-6.5 cm long, slightly decurved, angular, smooth, with dense short pedicellate flowers; the pedicellate ovary *c.* 0.3 cm long; the floral bract *c.* 0.25 x 0.15 cm, ovate acute with wavy margin. Flowers 0.56-0.6 cm long, orange yellow, sepals sub-equal, 3-nerved, yellow; the dorsal sepal 0.47-0.49 x 0.28-0.29 cm, oblong-ovate, concave, obtuse; the lateral pair 0.56-0.57 x 0.3-0.32 cm, triangular, ventrally united at base and dorsally keeled, yellow. Petals *c.* 0.3 x 0.12 cm, triangular, sub-acute, translucent white with a single median nerve. Lip *c.* 0.3 x 0.13 cm, oblong-ovate, slightly deflexed at the middle, the upper convex surface grooved to give two ridges on either side, the anterior half narrowed to the obtuse apex. Column *c.* 0.29 x 0.15 cm with two triangular, acute, subulate apical processes, slightly winged; the foot *c.* 0.15 cm long, curved; stigma orbicular. Anther *c.* 0.1 cm long, dome-shaped, papillose, two chambered. Pollinia four, oval, unequal, the two inner ones much reduced, yellow.

Type: INDIA: Sikkim, Lachung valley R.F., 25 July 1990. Phyangla R.F., 24 August 1991. Lucksom 207 a (Holotype : CAL : Isotypes : 207 b, c, d Gangtok, Forest Department, Herb.).

Flowers: July-August.

Fruits: November-December.

Ecology: Grows on steep rocky crevices and also on moss covered rocks. Altitude 1000-2135 m.

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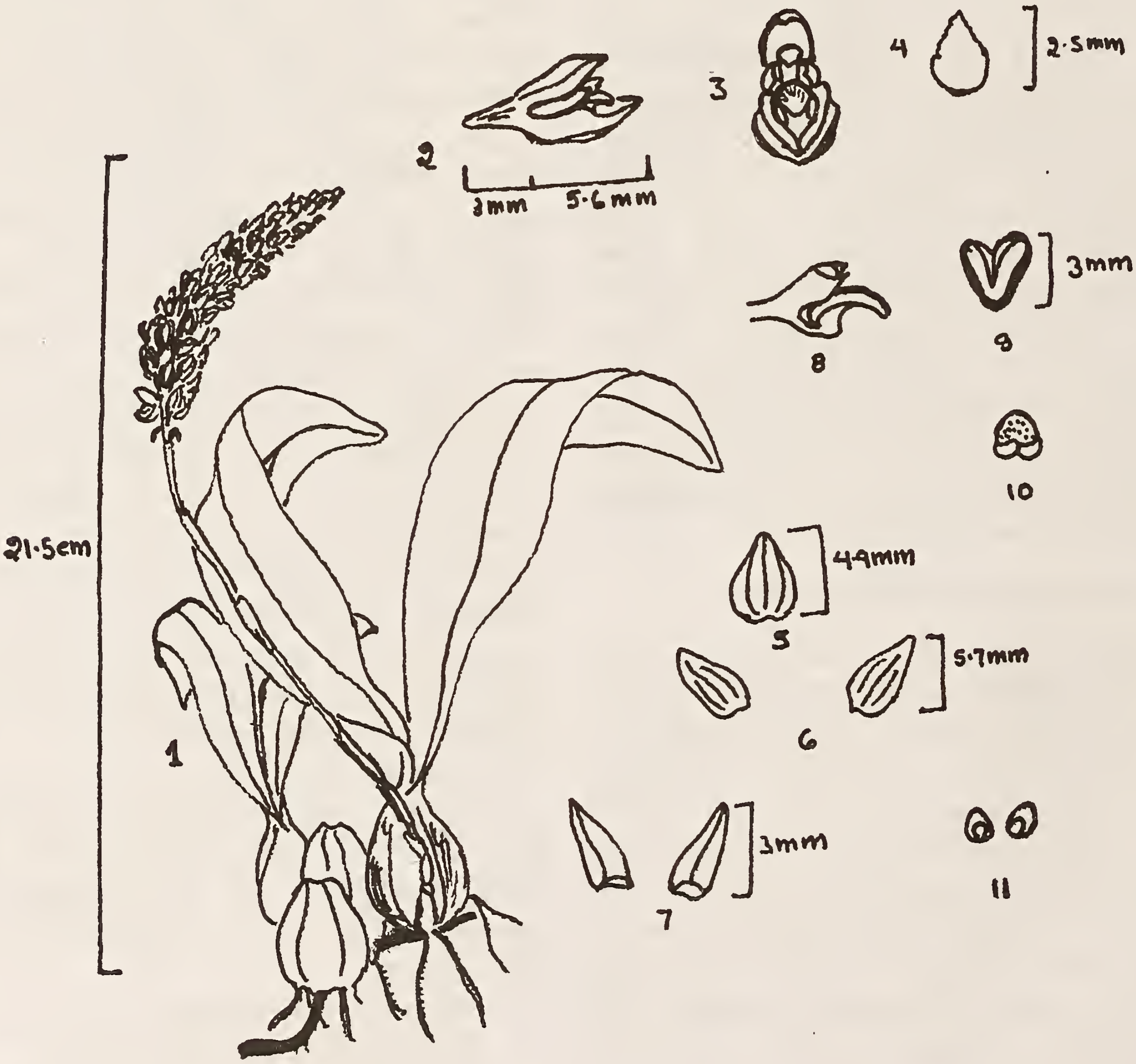
[1] Accepted September 1992.

[2] Divisional Forest Officer, M/E, Forest Department, Govt. of Sikkim, Gangtok, Sikkim.

TABLE 1
DIFFERENCES BETWEEN *Bulbophyllum triste* AND *B. flavida* SP. NOV.

	Bulbophyllum triste Rehb.f.	*Bulbophyllum flavida* sp. nov.
Rhizome	1.25-2.5 cm long, 0.38 cm diameter.	0.5-1 cm long, 0.4 cm diameter.
Pseudobulb	0.8-0.22 cm diameter, dorsoventrally flattened.	2.5-3.5 x 1.6-2.7 cm, oval, broadly ridged.
Leaf	7.5-12.5 x 1.5-2 cm, narrowly oblong, absent during flowering time.	15-21 x 0.6-2.7 cm, oblong-oblanceolate, present during flowering time.
Inflorescence	7.5-15 cm long.	14.5-21.5 cm long.
Peduncle	5.5-12 cm with a few filiform bracteoles.	10.5-15 cm long crowded bracts at the base and with 4-5 tubular sheathing bracts at nodes.
Raceme	2-3 cm long, drooping.	4-6.5 cm long, orange yellow, decurved.
Flowers	0.6 cm long, dull purple.	0.56-0.6 cm long, orange yellow.
Lateral sepal	Cohering to the tip.	Cohering to the base, dorsally keeled.
Lip	Upper surface convex and with divided protuberances.	Upper surface convex and grooved to give two ridges on either side.



Figs. 1-11. *Bulbophyllum flavida* sp. nov.
1. Whole plant; 2. Side view of flower; 3. Front view of flower; 4. Flowering bract; 5. Dorsal sepal; 6. Lateral sepal; 7. Petals; 8. Side view of column and lip; 9. Front view of lip; 10. Papillose anther; 11. Pollinia.

Some of the characteristics of genus *Bulbophyllum* are: Inflorescence racemose, usually strongly bent at the base of rachis; the lateral sepals less than twice the length of the dorsal sepal; flowers 0.56-6.00 mm long. The fresh specimens were found to be different in several characters from other *Bulbophyllum* species. The new taxon is closely allied to *Bulbophyllum triste* Rchb. f. from which it differs as shown in Table 1.

Etymology: Because of its prominent yellow colour the new species is named *flavida.*

ACKNOWLEDGEMENTS

My sincere thanks are due to Dr P.M. Singh, Scientist SB, Botanical Survey of India, Gangtok, for his valuable suggestions and Dr S. Kumar, Scientist SD, Botanical Survey of India, Gangtok, for going through the manuscript. Thanks are due to Mrs Kalyani Thapa, Curator of Gangtok Forest Department Herbarium, for making herbarium sheets, and to Dr N.C. Majumdar, Scientist SE (Retd.), Botanical Survey of India, for Latin translations.

THREE NEW GENERA OF COCCIDAE (HOMOPTERA : COCCOIDEA)[1]

RAJENDRA KUMAR AVASTHI[2]

(With two text-figures)

Three new genera: *Varshneococcus, Sharanococcus* and *Prococcus* based on *Coccus* species are proposed.

The revision of Indian species of *Coccus* Linnaeus reveals that the species *C. adersi* (Newstead), *C. bicruciatus* (Green), *C. watti* (Green) and *C. acutissimus* (Green) are not congeneric, though they have affinities with *Coccus* in the absence or presence of few tubular ducts on venter. The presence of oval anal plates in *C. adersi, C. bicruciatus* and *C. watti*; numerous stigmatic spines in *C. adersi*; reduced legs and antennae in *C. acutissimus* distinctly separate these species from *Coccus.* We therefore propose three new genera — *Varshneococcus* for *C. adersi, Sharanococcus* for *C. bicruciatus* and *C. watti*, and *Prococcus* for *C. acutissimus.*

KEY TO SOME RELATED GENERA OF COCCIDAE, BASED ON ADULT FEMALES

1. Legs and antennae well developed 2
— Legs and antennae absent or much reduced 6
2. Stigmatic spines 2-3 3
— Stigmatic spines numerous .... *Varshneococcus* gen. nov.
3. Anal plates together roughly quadrate with cephalolateral and caudolateral margins forming distinct lateral angles 4
— Anal plates together oval with cephalolateral and caudolateral margins fused together to form a continuous curve .... *Sharanococcus* gen. nov.
4. Stigmatic spines 3, median longer than laterals; para-opercular pores if present never extend up to head ... 5
— Stigmatic spines 2 of equal size on either end of the sclerotized band; para-opercular pores numerous, arranged in a band along median line of the body and extended as far as the head .... *Marsipococcus* Cockerell & Bueker
5. Dorsum with large tessellation... *Eucalymnatus* Cockerell
— Dorsum without tessellation .... *Coccus* Linnaeus
6. Cribiform plates present on dorsum 7
— Cribiform plates absent on dorsum.. *Prococcus* gen. nov.
7. Legs and antennae rudimentary; derm around anal plates unsclerotized .... *Cribrolecanium* Green
— Legs and antennae absent; derm around anal plates strongly sclerotized .... *Akermes* Cockerell

Genus **Varshneococcus** gen. nov.

Type-species: *Lecanium adersi* Newstead, 1917.

Diagnostic features: *Shape:* Mounted specimens irregularly oval. *Dorsum:* Setae

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minute and spiniform. Para-opercular pores and submarginal tubercles absent. Tubular ducts few on submargins of body. Anal plates together oval, with cephalolateral and caudolateral margins fused together to form a continuous curve; each plate with three apical and four subapical setae. *Margin:* Setae small, curved, dilated apically. Stigmatic clefts each with 18-24 cylindrical setae of variable length and diameter. *Venter:* Quinquelocular pores few near cleft and spiracular opening. Multilocular pores absent. Tubular ducts few, confined to genital opening. Antennae 7-segmented, sometimes 6-segmented. Legs well developed, without tibio-tarsal articulatory sclerosis; claws simple.

The new genus has affinities with *Sharanococcus* gen. nov. in having oval anal plates but distinctly differs from it in having numerous stigmatic spines. It is named after Dr R.K. Varshney, Scientist, Zoological Survey of India, Calcutta, for his contribution to the study of Coccoidea.

Varshneococcus adersi (Newstead), comb. nov.
(Fig. 1)

Lecanium adersi Newstead, 1917: 357.

Coccus adersi (Newstead); De Lotto, 1959: 155; Arasthi & Shafee, 1991: 330.

Material examined: One slide with two adult females, labelled: *Lecanium adersi* Newstead, from Mango, Zanzibar, 1913, R. Newstead (BMNH).

The species was redescribed and illustrated in detail by De Lotto (1959) and Avasthi & Shafee (1991).

Genus **Sharanococcus** gen. nov.

Type-species: *Lecanium bicruciatum* Green, 1904.

Diagnostic features: *Shape:* Mounted specimens more or less oval. *Dorsum:* Setae minute and spiniform. Para-opercular pores and submarginal tubercles absent. Anal plates together oval with cephalolateral and caudolateral margins fused together to form a continuous curve; each plate with three apical and one subapical setae. *Margin:* Setae small, curved, simple, bifid and fimbriate. Stigmatic clefts each with large chitinized rim and three spines. *Venter:* Quinquelocular pores in a row between spiracles and stigmatic clefts. Multilocular pores absent. Tubular ducts few, around genital opening only. Antennae 6 to 7-segmented. Legs well developed, without tibio-tarsal articulatory sclerosis; claws simple.

The genus is represented by two species. The new genus has affinities with *Varshneococcus* gen. nov. in having oval anal plates but distinctly differs from it in having three stigmatic spines. It is named after Dr. Sharan Behari Goswami, Ex-Principal, I.O.P., Vrindaban, for his constant inspiration for work.

KEY TO SPECIES OF *Sharanococcus* GEN. NOV.,
BASED ON ADULT FEMALES

1. Marginal setae bifid and fimbriate .... *S. bicruciatus* (Green)
— Marginal setae simple .... *S. watti* (Green)

Sharanococcus bicruciatus (Green), comb. nov.
(Fig. 2)

Lecanium bicruciatum Green, 1904 : 214.

Coccus bicruciatus (Green); Green, 1904: 248; De Lotto, 1957 : 299; Avasthi & Shafee, 1991 : 331.

Material examined: One slide with three adult females, labelled: *Coccus bicruciata* (Green), on *Capparis mitohrili*, August 12, 1931; Chinrhilla (NMNH).

The species was redescribed and illustrated in detail by De Lotto (1957) and Avasthi & Shafee (1991).

Sharanococcus watti (Green), comb. nov.

Lecanium watti Green, 1900 : 6.

Coccus watti (Green); Rao & Kumar, 1952 : 3; Avasthi & Shafee, 1991 : 345.

Saissetia watti (Green); Ali, 1971 : 45.

The species was redescribed and illustrated in detail by Rao and Kumar (1952).

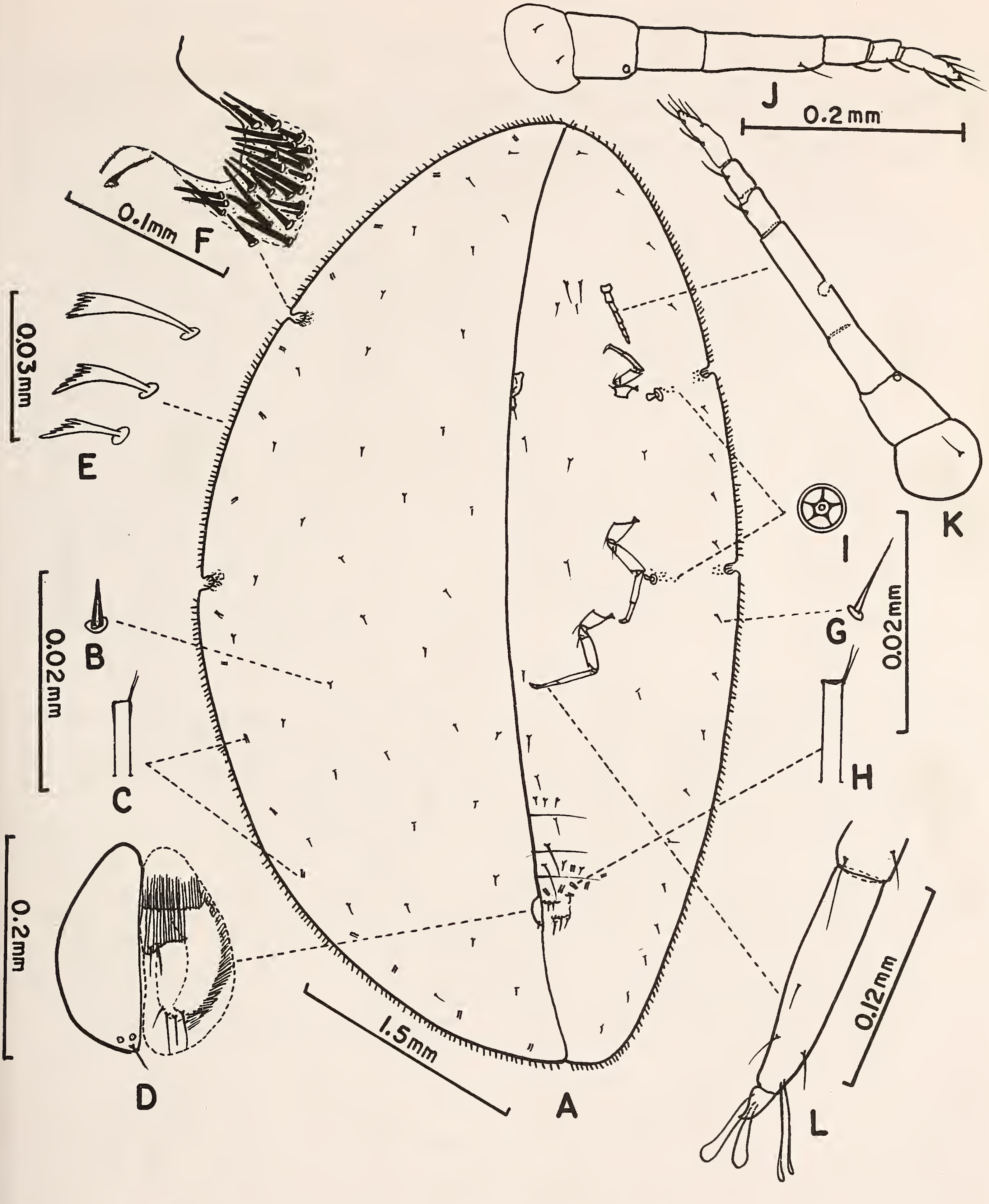
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Fig. 1. *Varshneococcus adersi* (Newstead) comb. nov. female. See text for explanations.

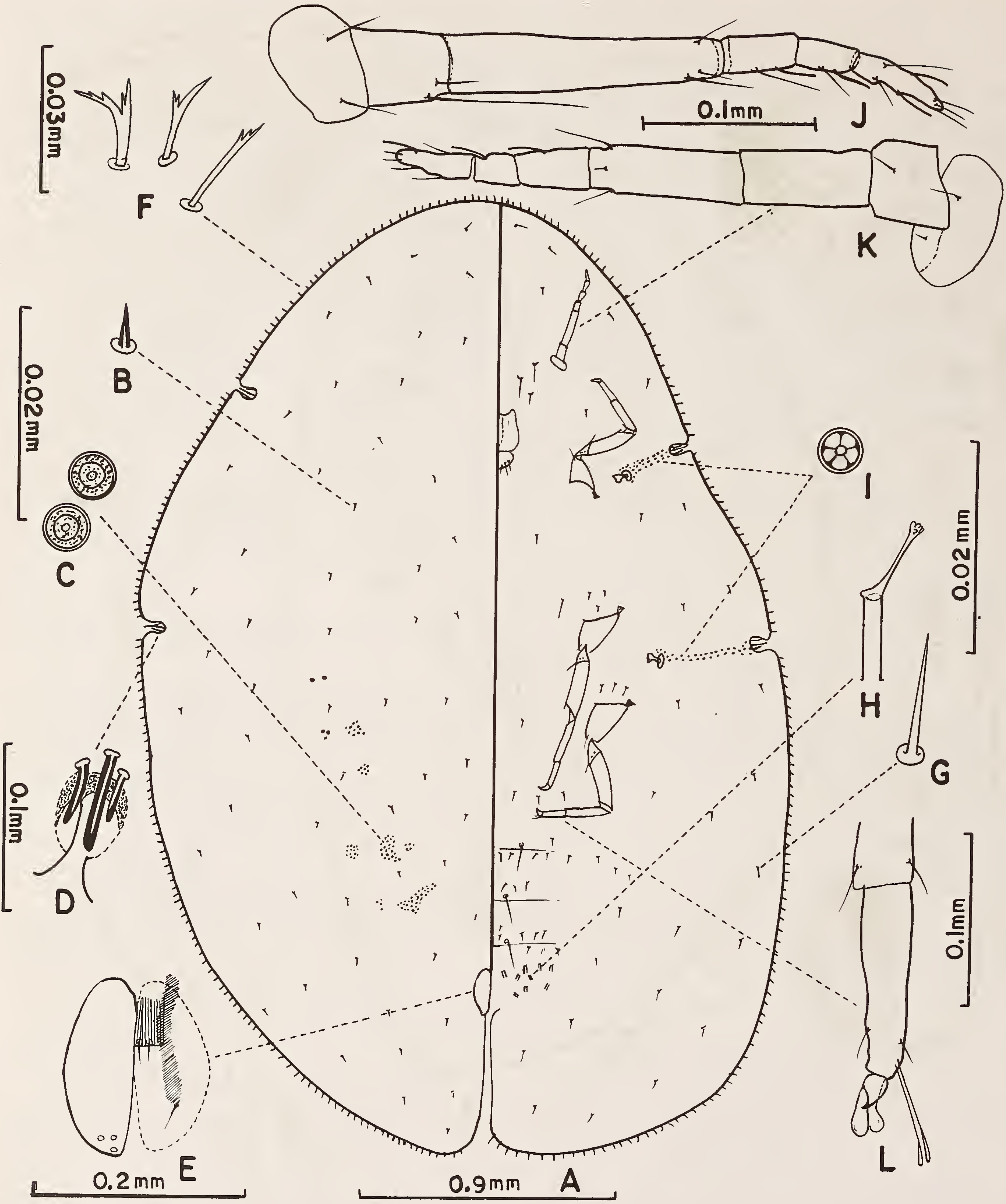
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Fig. 2. *Sharanococcus bicruciatus* (Green) comb. nov. female. See text for explanations.

Genus **Prococcus** gen. nov.

Type-species: *Lecanium acutissimum* Green, 1896.

Diagnostic features: *Shape:* Body of adult female elongate, slender and pointed at apices. *Dorsum:* Membranous but strongly sclerotized in older specimens. Setae spinose with pointed or blunt apices, clavate or cylindrical with almost truncate apices. Submarginal tubercles present. Para-opercular pores variable in number. Anal plates more or less quadrate with distinct lateral angles; each plate with two subapical, three apical and one subdiscal setae. *Margin:* Setae slender, pointed and sparse. Stigmatic clefts with three setae, median much longer than laterals. *Venter:* Quinquelocular pores in a single row between spiracles and stigmatic clefts. Multilocular pores few, confined in anal region and on preceding 2-3 abdominal segments. Tubular ducts absent. Antennae much reduced; 3-segmented, sometimes with membranous division indicating five segments. Legs greatly reduced, tibia and tarsus fused together; claws simple.

The new genus has affinities with *Cribrolecanium* Green in having reduced legs and antennae but distinctly differs from it in the absence of cribiform plates on dorsum. The generic diagnosis is based on the illustrations and description given by Gill *et al.* (1977) for *Coccus acutissimus* (Green).

Prococcus acutissimus (Green), comb. nov.

Lecanium acutissimum Green, 1896 : 10.

Coccus acutissimus (Green); Gill *et al.*, 1977 : 12; Avasthi & Shafee, 1991: 330.

Gill *et al.* (1977) redescribed and illustrated the species in detail.

ACKNOWLEDGEMENTS

I am thankful to Dr J.M. Cox, BMNH, London, Dr. D.R. Miller, U.S.D.A., Beltsville, Maryland, and Dr D.R. Davis, Chairman, Department of Entomology, NMNH, Washington D.C. for arranging the loan of the type material for study.

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A NEW SPECIES OF *BULBOPHYLLUM* THOUARS (ORCHIDACEAE) FROM SOUTHERN INDIA[1]

R. Gopalan and A.N. Henry[2]

(With six text-figures)

Bulbophyllum agastyamalayanum sp. nov.[3]

Bulbophyllum hymenanthum Hook. f. affinis, sed foliis petiolatis; scapo foliis longiore; floribus 6-12, umbellatis; sepalis dorsalibus oblongo-ellipticus, apicibus obtusis; petalis oblique ellipticus; labio ovato et in dimidio inferiore profunde sulcatis differt.

Allied to *Bulbophyllum hymenanthum* Hook. f. but differs in: leaves petioled; scape shorter than leaves; flowers 6-12 in umbels; dorsal sepal oblong-elliptic, obtuse at apex; lateral sepals obliquely falcate, obtuse at apex; petals obliquely elliptic; lip ovate, posterior half deeply grooved.

Herbs, epiphytic; rhizome woody, creeping with fibrous scales at nodes; internodes *c.* 5 mm long; roots slender, fibrous; pseudobulbs minute, very difficult to distinguish, up to 2 x 2 x 0 mm, green, naked, oblique, flat. Leaves 2.3-9.5 x 1.0-2.2 cm, solitary, *c.* 1.5 cm apart, thick, fleshy, elliptic, cuneate at base, obtuse at apex, faintly 1-nerved; petioles up to 2 mm long, fleshy, grooved adaxially. Flowers pink, 6-12 in umbels; peduncle up to 6 cm long, filiform, arising on rhizome in between leaves; bracts 1-2 x 1 mm, equal to or slightly longer than ovary, truncate-lanceolate, acuminate, acumen margin setaceous or papillate. Dorsal sepal 2.5-3 x 1.5 mm, oblong-elliptic, concave, base thick, margin entire and incurved, obtuse at apex, hooded, 3-nerved; lateral sepals 2.5-3 x 1-2 mm,, obliquely falcate, base oblique, attached to foot of column forming a mentum, margin entire, apex obtuse, 3-nerved. Petals maroon-coloured, 2-2.5 x 1 mm, obliquely elliptic, base thick, margin entire, acute at apex, 1-nerved, nerve raised dorsally. Lip 2 x 2 mm, yellow, ovate, convex, thick, deflexed, posterior half deeply grooved, attached to mentum, 3-lobed; lateral lobes two, very small or minute, erect; midlobe ovate, rounded, thick, fleshy, deflexed, apex obtuse, grooved from the base to the middle. Column short, up to 1 mm long with two horns (stelidia); horns up to 1 mm long, falcate. Pollinia two, yellow, small, obovate. Ovary 1-2 mm long, glabrous. Fruit globose, 8-10 x 5-7 mm, 6-ribbed (Figs. 1-6).

Holotype: *Gopalan* 96220, CAL. Isotypes *Gopalan* 96220, MH-acc. no. 155723-40. Poonkulam (1120 m) in Agastyamalai, Tirunelveli Kattabomman district, Tamil Nadu, 3 April 1991.

We are thankful to Dr N.P. Balakrishnan, Joint Director, for encouragement and to Dr V.J. Nair, Scientist 'SD' for rendering the Latin translation.

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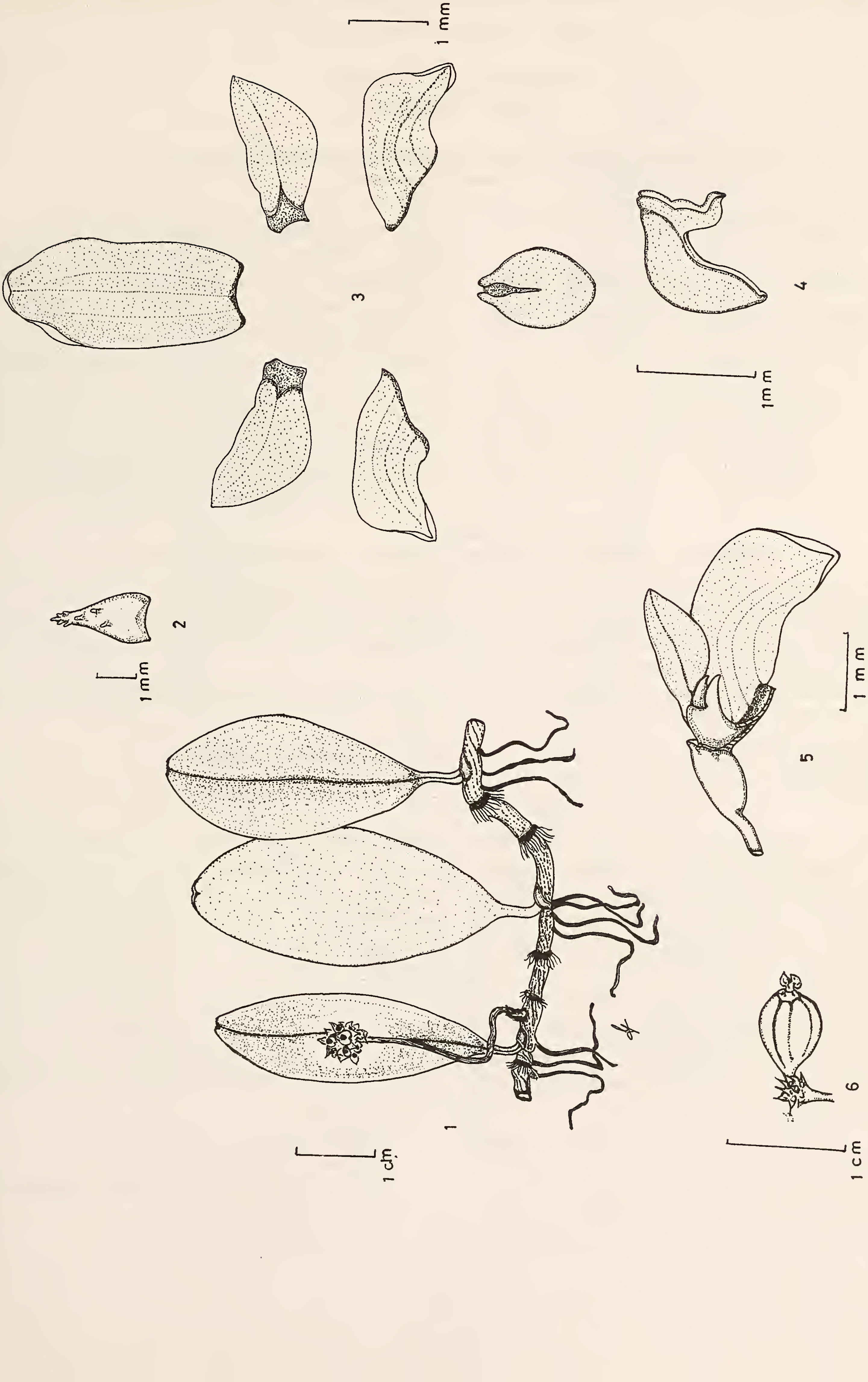
[1] Accepted July 1992.

[2] Botanical Survey of India, Southern Circle, Coimbatore-600 003.

[3] This species is named after the type locality.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Figs. 1-6. ***Bulbophyllum agastyamalayanum*** **sp. nov.**

1. Habit; 2. Bract; 3. Sepals, petals and lip spread out from front; 4. Lip – side view; 5. Flower – side view (dorsal sepal, one lateral sepal and one petal removed); 6. Fruit.

A NEW *PREMNA* L. (VERBENACEAE) FROM THE WESTERN GHATS OF TAMIL NADU[1]

A. Rajendran and P. Daniel[2]

(With a text-figure)

Premna mundanthuraiensis, a new species from the Mundanthurai Wildlife Sanctuary on the Western Ghats of Tamil Nadu, is described and illustrated.

Premna mundanthuraiensis sp. nov.[3] (Fig. 1)

P. corymbosa Rottler affinis males habitus effuso; partibus juvenibus glabris; foliis ovato-lanceolatis, ad margineum serratis; petiolis glabris; calycibus campanulatis differt.

Typus: Tamil Nadu, Tirunelveli dist., Mundanthurai Wildlife Sanctuary, Mundanthurai to Karaiyar, *c.* 670 m, 4 October 1987, *A. Rajendran* 86717 (CAL, holotypus; MH, isotypus).

Shrub, straggling, 2-3 m high; branches slender, obtusely 4-angular, glabrous; bark whitish yellow; leaf scars circular, prominent; nodes not annulate; internodes much abbreviated, 1-2 cm long. Leaves decussate-opposite, crowded at ends of branches, ovate-lanceolate, obtuse at base, serrate at margins with acute serrations, acuminate or rarely acute or obtuse at apex, 3.5-6.5 x 2.5-3.5 cm, chartaceous, pale green, sparsely pubescent; nerves on both surfaces densely pubescent; lateral nerves 4-6 pairs, distinct beneath; petioles slender, canaliculate, 1-1.5 cm long, minutely pubescent. Corymbs terminal, compact, composed of 3-5 decussate-opposite simple cymes, *c.* 2 x 1.5 cm; peduncles slender, 1-1.5 cm long; bracts lanceolate, *c.* 6 x 3 mm, pubescent. Flowers few, cream-coloured; pedicels *c.* 1 mm long. Calyx campanulate, 2-lipped, 5-toothed, *c.* 2 x 2 mm; teeth acute, sparsely pubescent outside. Corolla infundibular, 2-lipped, 4-lobed; upper lip 1-lobed, suborbicular, concave, obtuse, *c.* 2 x 1.5 mm; lower lip 3-lobed; lobes obovate, obtuse, subequal, *c.* 2 x 1 mm; tube narrow, ampliate towards apex, *c.* 2 x 1.1 mm, glabrous outside, densely villous at throat. Stamens four, didynamous; filaments slender, glabrous, 1.5-2 mm long, included; anthers globose, *c.* 0.2 mm, brown, 2-celled. Ovary subglobose, truncate at apex, *c.* 1 x 1 mm; style slender, *c.* 4 mm long, glabrous; stigma 2-lobed; lobes equal, subulate. Fruits not seen.

Flowers: October.

Fruits: Not common.

Habitat: Grows in scrub jungles, as-

TABLE 1

DIFFERENCES BETWEEN *Premna corymbosa* AND *P. mundanthuraiensis* SP. NOV.

	Premna corymbosa Rottler	*Premna mundanthuraiensis* sp. nov.
1.	Young parts densely villous; bark dark brown.	Young parts glabrous; bark whitish yellow.
2.	Nodes annulate, covered with a band of densely villous hairs; internodes not abbreviated.	Nodes not annulate, glabrous; internodes much abbreviated.
3.	Leaves not crowded at the end of the branches, ovate or ovate-cordate, entire.	Leaves crowded at the end of the branches, ovate-lanceolate, serrate.
4.	Corymbs terminal and axillary.	Corymbs terminal.
5.	Calyx cupular, *c.* 3 x 3 mm.	Calyx campanulate, *c.* 2 x 2 mm.
6.	Corolla upper lip *c.* 4 x 3 mm.	Corolla upper lip *c.* 2 x 1.5 mm.

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[1] Accepted July 1992.

[2] Botanical Survey of India, Southern Circle, Coimbatore-641003.

[3] This species is named offer the type locality.

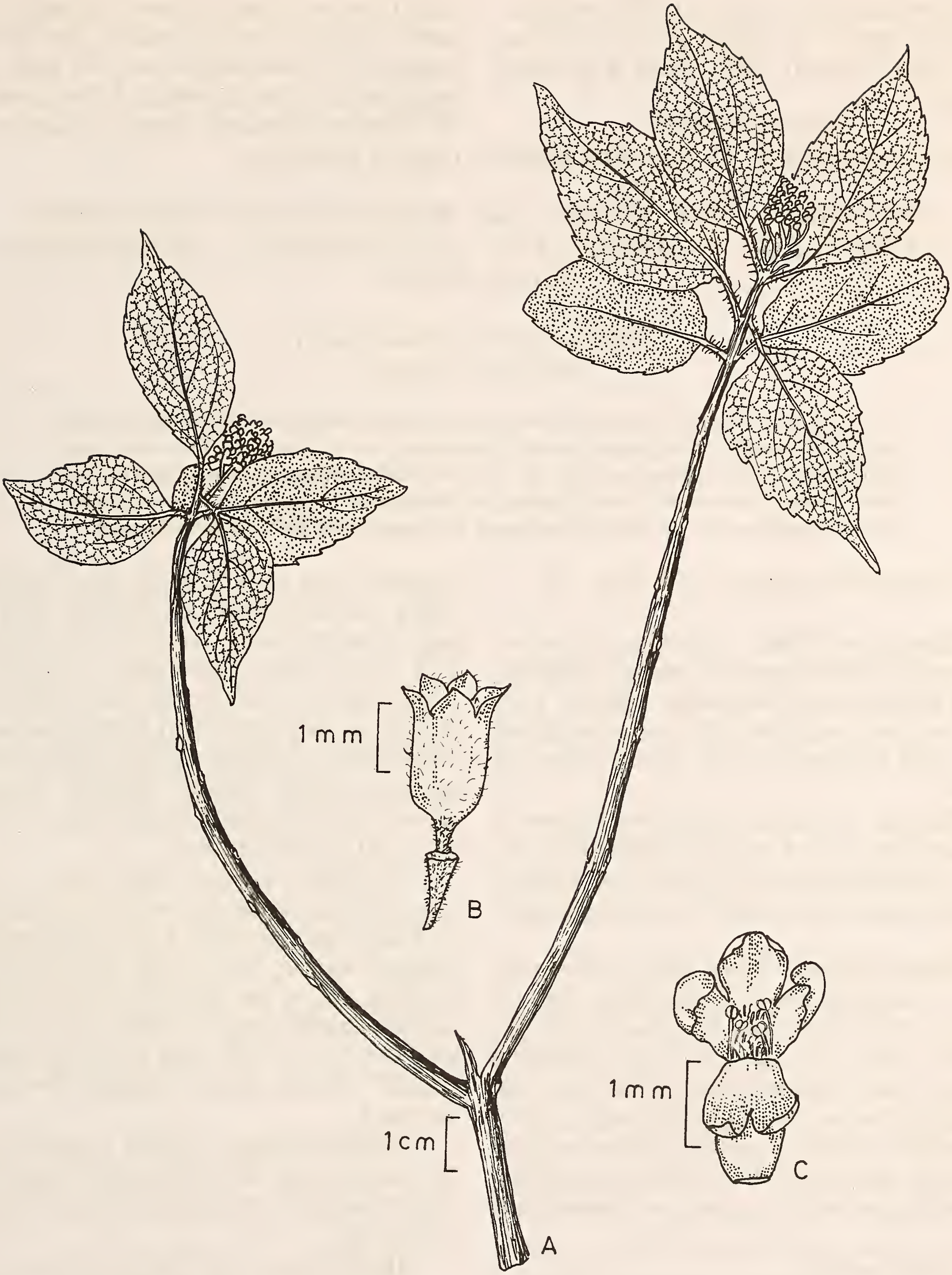
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Fig. 1. *Premna mundanthuraiensis* sp. nov.: A. Twig; B. Calyx; C. Corolla.

sociated with *Lantana camara* L. Not common.

This species is allied to *P. corymbosa* Rottler, but markedly differs from it as shown in Table 1.

ACKNOWLEDGEMENTS

We are thankful to Dr N.P. Balakrishnan, Joint Director, Botanical Survey of India, Coimbatore, for the facilities and to Dr V.J. Nair, Scientist SD, Botanical Survey of India, Shillong, for the Latin diagnosis. AR is thankful to the Director, Botanical Survey of India, for a research fellowship.

ON THREE NEW SPECIES OF WHITEFLIES OF THE TRIBE DIALEURODINI SAMPSON, 1943 (ALEYRODIDAE : HOMOPTERA) FROM INDIA[1]

K. REGU AND B. VASANTHARAJ DAVID[2]

(With nine text-figures)

During the survey of whiteflies from different parts of India from 1987-1990 three new species of whiteflies belonging to the tribe Dialeurodini, viz. *Cockerelliella rotunda* sp. nov., *Dialeurodes (Gigaleurodes) splendens* sp. nov. and *Dialeuronomada saklespurensis* sp. nov. were collected respectively from *Capparis* sp. (Capparaceae), *Homonoia riparia* (Euphorbiaceae) and *Dimocarpus longon* (Sapindaceae). These species are described and illustrated.

Cockerelliella rotunda sp. nov. (Figs. 1-4)

Pupal case: White, without wax secretion, submargin folded downwards, broadly elliptical, widest across second abdominal segment, 1.03-1.06 mm long and 0.96-0.99 mm wide; found singly and in groups on the lower surface of leaves.

Margin: Crenulate, 24-27 crenulations in 0.1 mm; thoracic and caudal tracheal pores distinct with chitinised rim; anterior and posterior marginal setae 20 µm and 17.5 µm long respectively.

Dorsal surface: Three pairs of fimbriate setae — cephalic setae 35 µm long, first abdominal setae 35-40 µm long and eighth abdominal setae 17.5-22.5 µm long; submargin 205 µm wide, separated from dorsal disc only on cephalothorax by cephalothoracic suture; longitudinal moulting suture reaches margin, transverse moulting suture reaches submargin. Cephalothorax with five pairs of submarginal fimbriate setae each 22.5 µm long. Subdorsum with a row of four pairs of fimbriate setae and a pair of pointed setae on abdomen, each 22.5-27.5 µm long. Numerous tubercles on cephalothorax evident. Median darker area present on each abdominal segment suture and characteristic markings evident from abdominal segment sutures laterad. Dorsum completely covered with elongated or polygonal markings; pores and porettes evident.

Vasiform orifice subcordate, slightly notched at the caudal end, wider than long, 47.5-52.5 µm wide and 45-47.5 µm long; operculum similarly shaped, 35-37.5 µm wide and 27.5-30 µm long, filling the orifice and concealing the lingula. Caudal tracheal furrow 137.5-145 µm long and 10 µm wide with polygonal markings evident, whereas thoracic tracheal furrows not indicated.

Ventral surface: Ventral abdominal setae 30 mm long and 45-50 µm apart. Thoracic and caudal tracheal folds distinct without stipples or sculpturing.

Host: *Capparis* sp. (Capparidaceae).

Material examined: Holotype: *Capparis* sp.,Munchirai (Tamil Nadu), 3 August 1987,

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[1] Accepted October 1992.

[2] Frednick Instt. of Plant Protection and Toxicology, Padappai 601 301.

Coll. K. Regu.

Paratypes: 18 pupal cases on slides bearing the same details as of holotype. Of these one paratype deposited in the collections of Division of Entomology, Indian Agricultural Research Institute, New Delhi.

This species resembles *Cockerelliella zingiberae* Sundararaj and David (1991a) in the presence of cephalothoracic fold and differs from it in the presence of fimbriate dorsal setae.

Dialeurodes (Gigaleurodes) splendens sp. nov. (Figs. 5-7)

Pupal case: Oval, white, without wax; 0.76-0.79 mm long and 0.55 mm wide, found on the lower surface of leaves.

Margin: Irregularly crenulate, thoracic and caudal tracheal pores with internal teeth evident, anterior marginal setae 20 µm long, posterior marginal setae 25-30 µm long.

Dorsal surface: Four pairs of dorsal setae — cephalic setae 35-50 µm long, first abdominal setae 17.5 µm long, eighth abdominal setae cephalo-laterad of vasiform orifice, 2.5 µm long and submarginal caudal setae 10-15 µm long. Longitudinal moulting suture reaches margin and transverse moulting suture reaches subdorsum. Six pairs of submarginal setae — one pair on cephalic region and five pairs on abdomen, each 20-32.5 µm long; a pair of minute setae below the vasiform orifice within the caudal furrow 5 µm long. Subdorsal mesothoracic and metathoracic setae each 27.5 µm long. Tubercles running along cephalothoracic and abdominal segment sutures prominent. Dorsum completely covered with tubercles. Seventh and eighth abdominal segments are of equal size (30 µm).

Vasiform orifice subcordate, wider than long, 47.5-52.5 µm wide and 45-47.5 µm long; operculum similarly shaped, wider than long, 32.5-35 µm wide and 30-32.5 µm long, filling the orifice and concealing the lingula. Caudal tracheal furrow distinct, 87.5 µm long and 20 µm wide with numerous round markings. Thoracic tracheal furrow indistinct.

Ventral surface: Ventral abdominal setae 20 µm long and 35 µm apart; a pair of minute setae at the base of rostrum evident.

Host: *Homonoia riparia* Lour. (Euphorbiaceae).

Material examined: Holotype: *Homonoia riparia*, Rajapalayam (Tamil Nadu), 11 June 1989, Coll. K. Regu.

Paratypes: Four pupal cases on slides bearing the same details as of holotype. One paratype deposited in the collections of Division of Entomology, Indian Agricultural Research Institute, New Delhi.

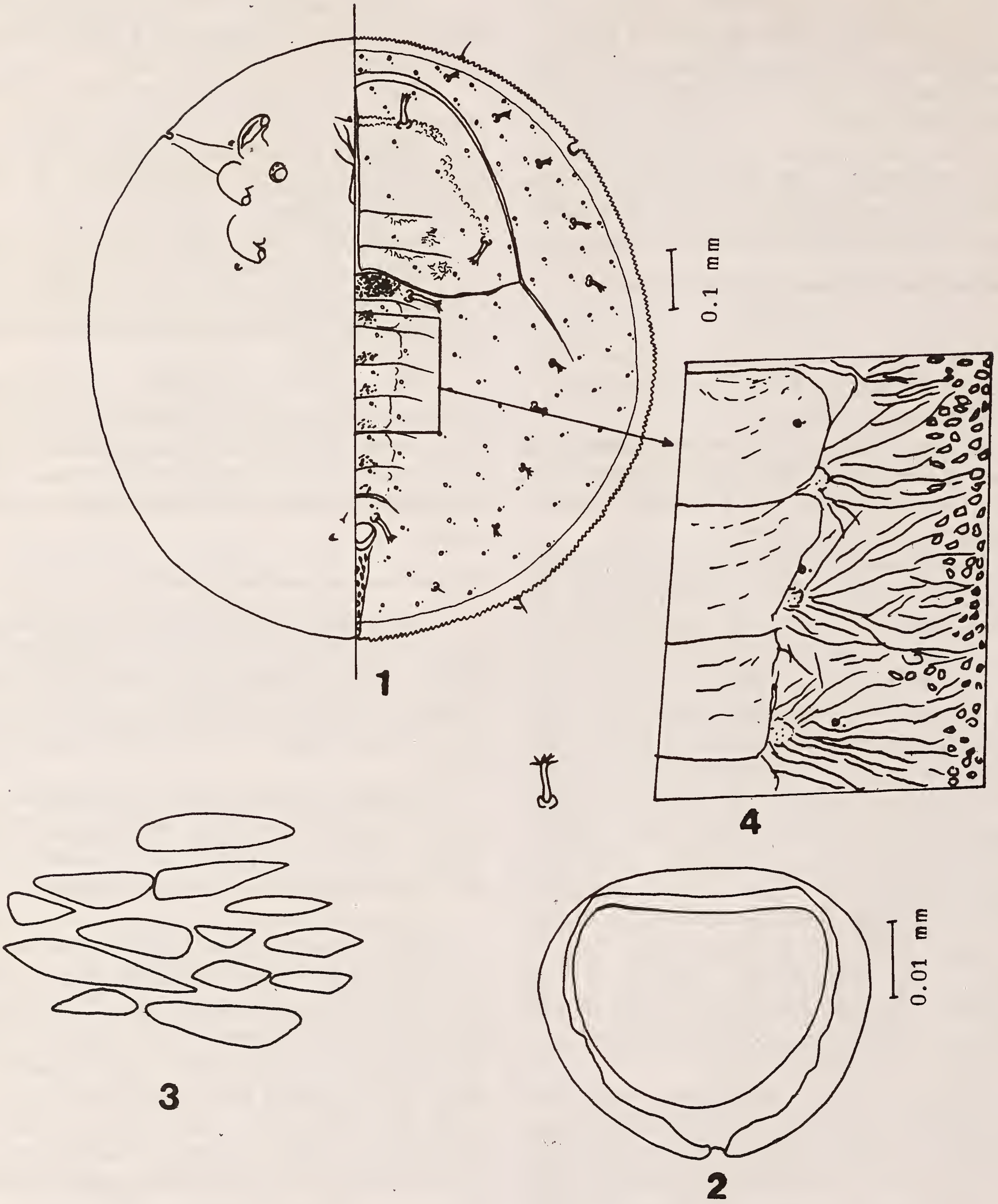
This species resembles *Dialeurodes (Gigaleurodes) multipori* Takahashi (1932) in the presence of tubercles on dorsum and differs from that in the presence of meso- and metathoracic setae and tubercles along segment sutures.

Dialeuronomada saklespurensis sp. nov. (Figs. 8-9)

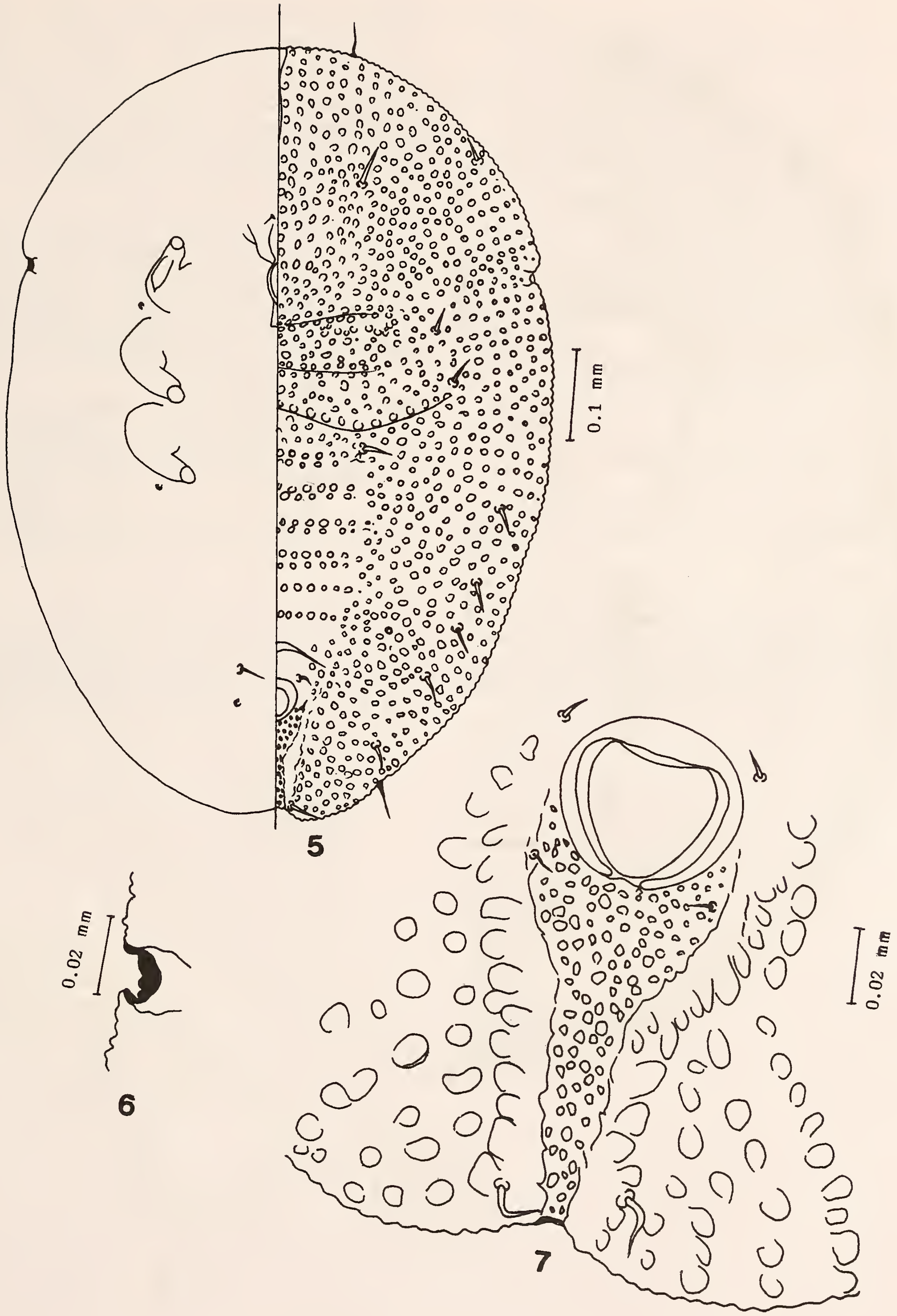
Pupal case: White and very thin pupal case with a little powdery wax around margin and on dorsum; oval, broadest across third abdominal segment; 1.00-1.14 mm long and 0.87-0.91 mm wide; found singly on the lower surface of leaves.

Margin: Smoothly crenulate, thoracic and caudal tracheal pore areas differentiated from margin; anterior marginal setae (broken) and posterior marginal setae 25-32.5 µm long.

Dorsal surface: Four pairs of dorsal setae — cephalic setae 12.5 µm long, first abdominal setae 5 µm long, eighth abdominal setae 45 µm long and submarginal caudal setae 20- 22.5 µm long. Submargin separated from dorsal disc by a thin furrow and submargin with suture-like lines running mesad from margin; a row of 11 pairs of submarginal setae — five pairs on cephalothorax and six pairs on abdomen each 22.5-27.5 µm long; a prominent peripheral row of papillae laterad of abdominal segments and pro-mesothoracic segments on subdorsum, the papillae near the vasiform orifice enlarged; pro-



Figs. 1-4. *Cockerelliella rotunda* sp. nov.
1. Pupal case; 2. Vasiform orifice; 3. Dorsal markings; 4. Median area of abdomen enlarged.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Figs. 5-7. ***Dialeurodes (Gigaleurodes) splendens*** sp. nov.
5. Pupal case; 6. Thoracic tracheal pore with margin; 7. Vasiform orifice with caudal tracheal furrow.

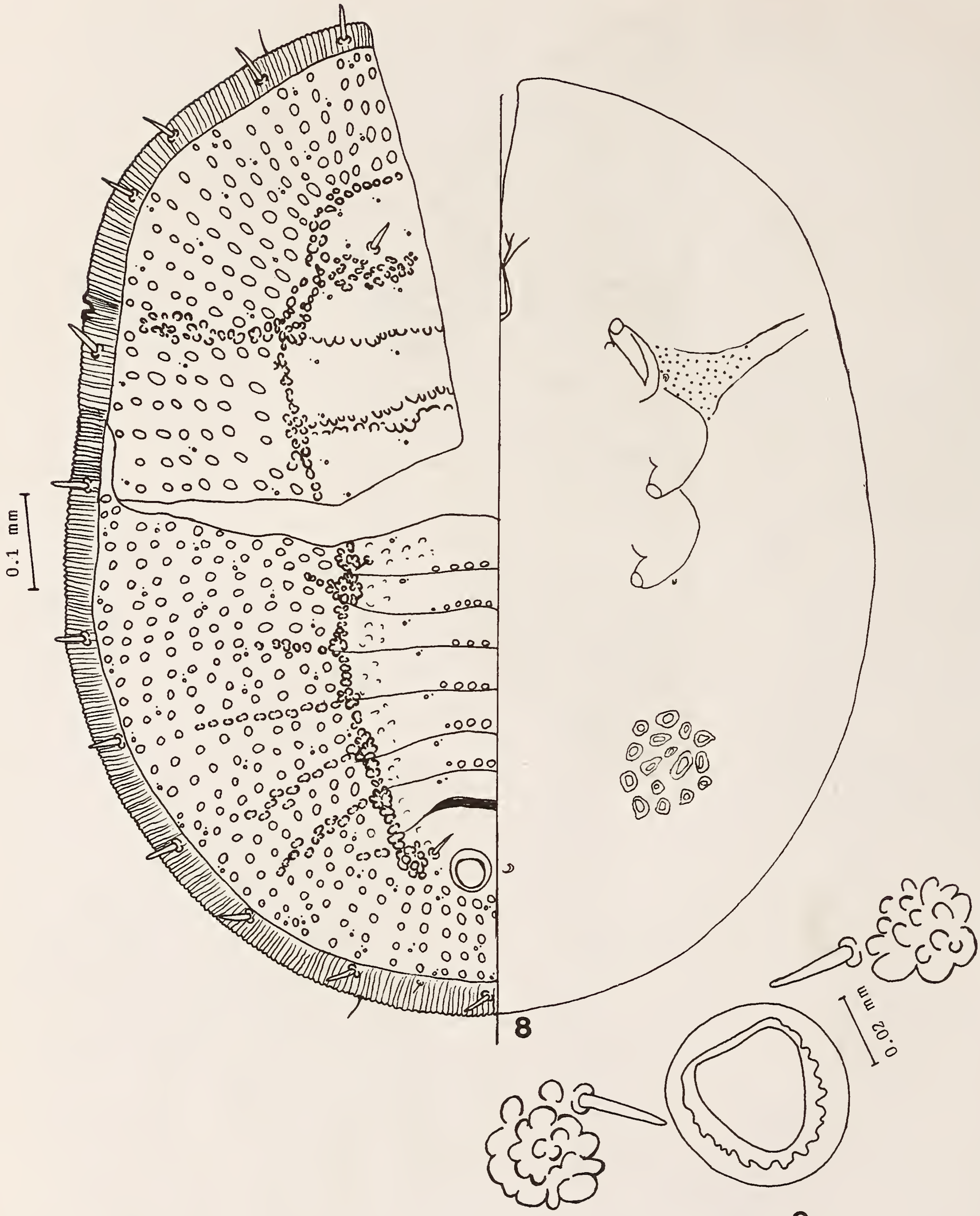

Fig. 8-9. *Dialeuronomada saklespurensis* sp. nov.
8. Pupal case; 9. Vasiform orifice with lateral papillae.

mesothoracic and meso-metathoracic sutures with papillae evident; abdominal segment sutures tuberculated. Pores and porettes sparsely distributed throughout dorsum. Longitudinal and transverse moulting sutures reach submargin. Subdorsum completely covered with round markings.

Vasiform orifice subcordate, with comb of teeth on its inner caudal and lateral margins, slightly longer than wide, 50 µm long and 47.5 µm wide; operculum 27.5-35 µm long and 27.5-32.5 µm wide, filling the orifice and concealing the lingula.

Ventral surface: Venter with round and polygonal markings; mouth parts, legs and spiracles evident; thoracic tracheal folds with stipples evident.

Host: *Dimocarpus longon* Lour. (Sapindaceae).

Material examined: Holotype: *Dimocarpus longon*, Saklespur (Karnataka), 4 February 1990, Coll. K. Regu.

Paratypes: Four pupal cases on slides bearing the same details as of holotype.

This species resembles *D. martini* Sundararaj and David (1991b) by the presence of enlarged papillae laterad of vasiform orifice and differs from that in the presence of round markings on dorsum and tubercles on abdominal segment sutures.

This species is named after the collection locality, Saklespur (Karnataka).

ACKNOWLEDGEMENTS

Thanks are due to S. James Fredrick, Chairman, FIPPAT for facilities provided.

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MISCELLANEOUS NOTES

1. ON MUTANT LEOPARDS *PANTHERA PARDUS* FROM INDIA

Among the large felids, partial albinism is not an uncommon phenomenon. Though there are no records of such aberrations among Asiatic lions *Panthera leo persica* in India, instances of albinism have been reported from South Africa (McBride 1977). There were as many as 17 instances of 'white' tigers in India between 1907 and 1933 (Gee 1954) and there was the famous Mohun from Rewa and his progeny of a later day which are too well known to require elucidation. There is also one instance of a 'white' cheetah *Acinonyx jubatus* from central India, the only one recorded anywhere (Divyabhanusinh 1987).

As far as leopards are concerned, the phenomenon appears to be extremely rare and very few records exist. I have consolidated here all the instances I have come across which should be of interest to the readers of the *Journal.*

1. In 1905 there was a report of a light coloured animal from Central India: "One leopard (*taindua*) of sandalwood (*sandli*) colour was killed at Jhinna [near Ajaigarh, Panna District, M.P.]. It was a very large leopard. Such a sandalwood coloured leopard has not been seen or heard of and its skin still exists today" (Ajaigarh 1914, p. 47).

2. In *c.* 1910 a white leopard was reportedly shot in Dumraon in Bihar, of which there are no details (Musselwhite 1933, p. 104).

3. In 1937, there was a 'likely' report of a police officer having shot a white leopard in Dumraon; there is no skin in existence of this specimen (Musselwhite 1933, p. 104).

4. In 1940 a white female was shot by a Boris Lissenovitch 15 miles from Sarasaran (sic.) near Dumraon. "When shot the eyes were sky blue — there was no trace of pink in the eye — and the tail shows just a suggestion of the original leopard. The animal is white at the sides and cream towards the centre with pale brown spots." There is a picture of a white leopard in the same report (presumably the same animal) which was six years old and was 6′6" between pegs (Musselwhite 1933, pp. 97, 104).

The book from which three of the above records are cited was published in 1933 and nowhere in it are a subsequent edition and date mentioned. Yet, its text gives the date as February 1940 of the white leopards at number 4 above. This clearly is an error and the correct date could well be 1930. If so, the dates of the animals referred at 2 and 3 above would be different as well.

5. There is yet another instance of a male white leopard, about 6′ 9" in length, with sandalwood coloured light spots on its body which was shot by a villager *c.* 1965 in village Aramgang of Ajaigarh tehsil of Panna district, Madhya Pradesh. This village is not very far from Jhinna mentioned in 1 above. The skin was acquired by the late Raja Bahadur Kaushalendra Sinhji and the mounted trophy is in the Ajaigarh Palace (Vansda, pers. comm. 1984).

6. M/s Van Ingen & Van Ingen of Mysore have recorded receiving a white leopard skin from Tikamgarh near Orcha in Madhya Pradesh (Van Ingen, pers. comm. to Vansda, 1967). The Maharaja of Orcha informed he has been unable to find any information regarding this specimen (pers. comm. 1991).

7. One skin of a leopard from Hazaribag in which "the ground colour is much paler than usual, almost cream and the pattern is tan" is preserved in the British Museum, London (Pocock 1939, p. 224).

8. A "white (albino) leopard" was recorded by Buchanan-Hamilton according to one source (Lydekker 1907, p. 318), while another states that "Blanford cites a figure of a white one [leopard] in Buchanan-Hamilton's drawings" (Finn 1929, pp. 84-85).

9. One "skin which was normal except for having the spots light brown instead of black" has been recorded but no further details are available (Finn 1929, p. 85).

From this examination it may be observed that three instances are from Dumraon and one from Hazaribag, both in Bihar and three are from Ajaigarh and Orcha in Madhya Pradesh.

Incidentally the only recorded white cheetah nearly 400 years ago, belonged to the Raja of Orcha, and it is likely that it came from the same locality. It is noteworthy that all the instances from the Indian subcontinent which can be ascribed a locality, are from these two pockets only. However, no conclusions can be drawn from this as other instances of mutant leopards could have gone unrecorded on the one hand and on the other, mention of such instances in vernacular literature or for that matter in English literature could have gone unnoticed by me in spite of my having examined all available sources of the latter.

In addition to the instances from India, a white leopard has been reported from Rhodesia (Zimbabwe) and R.I. Pocock "saw one purely white skin, apparently from East Africa, in which spots were only visible in reflected light" (Guggisberg 1975, p. 220).

I would be glad to receive additional information on the subject.

I am grateful to Maharawalji Shri Digveerendrasinhji of Vansda for drawing my attention to the Ajaigarh and Orcha instances.

January 31, 1992 DIVYABHANUSINH
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2. FIRST RECORD OF TIGER *PANTHERA TIGRIS* IN DALMA WILDLIFE SANCTUARY, BIHAR, AND ITS PREDATION ON SLOTH BEAR *MELURSUS URSINUS*

There is no record of the tiger *Panthera tigris* in the recent past in Dalma Wildlife Sanctuary, Bihar. A tiger took refuge in the Sanctuary for almost two years from January 1989 to November 1990. The Sanctuary and the surrounding areas are partially or almost completely degraded due to urbanization, mining activity and agricultural encroachment. No suitable prey species is available in the forest. The nearest known tiger habitats are Hazaribagh Wildlife sanctuary to the north-west and Simlipal Tiger Reserve to the south-west; both are more than 100 km away. The origin and disappearance of the tiger is still a mystery but there is no doubt that it was leading a nomadic existence and may have been killed due to its cattle lifting prowess, and the hunting habits of the local people.

The tiger during its two year stay at the Sanctuary had taken to cattle lifting and had somewhat solved the cattle problem in the core area. During 1989 and 1990 I found six cases of bear being eaten by this tiger within the core area of 55 sq. km. In three cases the head was intact and front and hind paws were found nearby. The remaining three cases were inferred from claws and hair in the faeces. Bears are in good number in Dalma due to the absence of large predators but are annually hunted down during the infamous ritual tribal hunt.

There are several instances of tiger predating on sloth bear recorded in the past (Campbell 1893, Clutterbuck 1894, Butler 1899, Fenton 1909, Pitman 1911, Duke 1919). There is a case of a full grown Malayan sun bear *Helarctos malayanus* being killed and devoured by a tiger in the Perak state of Malaysia (Spooner in Butler 1899). Some of these authors were told by their guides or locals that these incidences were not uncommon. To me it appears to be a secondary preference of the tiger, considering the risk of the prey fighting back and the small number of bears available compared to other prey species in the tiger's home range.

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PITMAN, C.R. (1911): Tiger taking off carcass of sloth bear. ibid. *22:* 619.

3. FIRST RECORD OF THE FISHING CAT *FELIS VIVERRINA* BENNETT IN DALMA WILDLIFE SANCTUARY AND CHHOTANAGPUR PLATEAU OF BIHAR

I worked on the BNHS Elephant Ecology Project at Dalma Wildlife Sanctuary, Bihar, from January 1989 to May 1992. On 17 March 1990 there was a cyclonic storm in the Bay of Bengal and its effects were felt in the southern parts of Bihar where the Sanctuary is situated. I was walking down a forest road the next day to see the effects of the previous day's storm and heard a mewing sound, the source of which was a fishing cat (kitten) *Felis viverrina*. The kitten,which was about the size of a three month old domestic cat, was apparently following its mother and must have become separated in the heavy gale and rain.

The kitten was located at about 800 m above msl in a rocky area surrounded by good forest cover, on the northern (cooler) aspect of Kotasini hill. It was under the care of Forest Department, and died in captivity after two days from unknown causes, although its behaviour was just like that of a healthy domestic kitten.

The fact that this species has not been recorded previously by the Sanctuary officials and tribals of the area who criss-cross the Sanctuary regularly, reflects the secretive habits of the species.

THE FAUNA OF BRITISH INDIA (Mammalia, Vol. 1, Pocock, R.I. 1939) gives the closest distribution of the species as reed beds near Calcutta and the area east of Bay of Bengal. Other areas of distribution are parts of terai, Bharatpur, Western Ghats, Sind province, Kumaon, Nepal and Sri Lanka (Ellerman, J.R.E. and Morrison-Scott, T.C.S., CHECKLIST OF PALEARCTIC AND INDIAN MAMMALS, 1951).

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4. DIETARY OF THE CATTLE EGRET *BUBULCUS IBIS COROMANDUS* (BODDAERT)

While several species of insects together with tadpoles, frogs and lizards are listed in the dietary of our commonest egret, the cattle egret *Bubulcus ibis coromandus*, fruits have not been recorded so far.

It was therefore surprising to see quite a few of these birds on 11 June 1988 during a morning's walk, helping themselves to banyan *Ficus bengalensis* figs. Their scrambling among the branches and peering amidst the foliage gave me the impression that they were breeding individuals. However, a careful look through binoculars revealed that they were selectively pecking at the figs and plucking what they thought to be the choicest among them, and gulping them whole.

August 10, 1991 NARESH CHATURVEDI
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5. FOOD PIRACY BY A WHITE STORK *CICONIA CICONIA* (LINN.)

On 16 February 1990, at about 1100 hrs, we were on a general reconnaissance of the reedy areas of Chhari-Dhand, Kutch, Gujarat. During this reconnaissance we observed a marsh harrier *Circus aeruginosus*, preying on an Indian mole rat *Bandicota bengalensis*. The harrier was devouring its prey on the ground, while at a short distance six white storks *Ciconia ciconia*, were stalking some prey in the marshy area. Suddenly one of these storks ran towards the marsh harrier, clattering its bill, and grabbed the rodent from the harrier. It soon gulped the prey down. The dispossessed harrier flew away, without making any effort to repossess its prey.

This incident of food piracy by white stork is interesting and has not been reported earlier.

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November 16, 1990 J.K. TIWARI
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6. CONTENTS OF A NEST OF THE TAWNY EAGLE *AQUILA RAPAX VINDHIANA* FRANKLIN

On 26 January 1991, during a general reconnaissance, we came across the nest of a tawny eagle *Aquila rapax vindhiana* in the Chach area of Chhari Dhandh (taluka Nakhtrana, district Kutch). The nest details are as follows.

Nest height *c.* 3 m, tree height *c.* 4 m, nesting tree *Prosopis chilensis*. The nest contained three fledgelings, one of them dead and maggot-ridden.

We collected the food remains from the nest. These consisted of two snake skeletons, each about 50 cm long, and one fore- and one hindlimb of a jungle cat *Felis chaus*. According to the HANDBOOK OF BIRDS OF INDIA AND PAKISTAN (Ali, S. and Ripley, S.D. 1987) the food of *Aquila rapax vindhiana* comprises of small mammals, birds and reptiles, mostly pirated from other hawks and kites, and scavenged from carrion and garbage.

The remains of a jungle cat's limbs inside the nest is interesting and hitherto not reported.

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7. AN UNUSUAL NESTING OF A GREY PARTRIDGE *FRANCOLINUS PONDICERIANUS* (GMELIN)

A housing colony called 'Gokul Nagar' has been recently established on the outskirts of Udaipur. A school in the colony owns a large piece of land which is covered by some trees and bushes. The area once had partridges in good numbers. As cement and bricks started piling up, all the partridges moved away except one pair, which took up its quarters in the school compound. Food is no problem for the birds as one of the inhabitants of the colony habitually scatters grain for the birds.

Adjacent to the school is an undeveloped piece of land and next to this plot lies a house with a masonry boundary wall crowned with thorns of babool tree *Acacia nilotica*. On 3 March 1991 we observed a female partridge examining numerous gaps and holes in the wall. Finally she chose a hole in the wall, 1.05 m from the ground, and started building her nest. She first screened the hole with babul thorns and then impaled on them leaves of the jamun tree (*Euginea jambolan*). She lined her nest with leaves of jamun and kaner trees (*Nerium indicum*).

On 13 March we found eggs in the nest; the hen remained on the eggs all through that day and night except for one hour (1700-1800 hrs). At about 1645 hrs the male of the pair started calling. After about 15 minutes of calling (1700 hrs) the female left the nest for foraging. Food being aplenty and water too being close by, she was back at the nest by about 1800 hrs. She kept up this routine till the eggs hatched.

On 2 April 1991 at about 1000 hrs, we noticed the hen with three chicks hiding in a bush on the vacant piece of land. She was constantly trying to take the chicks into the safety of the school compound but the wall seemed to be too high for the chicks. A pariah dog spotted the hen and chicks and rushed towards them. We shooed the dog away and putting the chicks into a basket, lowered them into the school compound. Soon the chicks were escorted away by both male and female. Examining the nest we found that all the eggs had hatched, but two chicks were found dead just below the nest. We failed to ascertain the cause of death.

Probably circumstances, especially predators like cats and dogs, forced this hen to build her nest above the ground and develop new means (thorns and leaves) to camouflage it as she did.

RAZA TEHSIN
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8. BREEDING OF LARGE INDIAN OR ORIENTAL PRATINCOLE *GLAREOLA PRATINCOLA MALDIVARUM* J.R. FORSTER IN KERALA

The first sight record of the Oriental pratincole *Glareola pratincola* ssp. in Kerala was at Kattampally (*c.* 11°55′ N, 75°20′ E) in 1984 (*JBNHS 87:* 296). Since then, these birds ranging in numbers from eight to 25 were found at Kattampally in April and May (1985 to 1991). These birds belong to the Oriental race *G.p. maldivarum* — the white trailing edge of wings being absent, tail fork rather shallow and closed wings extending well beyond the tail. All the birds seen were adults in breeding plumage — creamy throat outlined in distinct black 'gorget'. Pair formation was also observed especially when the birds alighted on the ground.

On 15 May 1991, I and Jafer Palot found a nest containing two eggs being incubated; on 24 May a second nest, also with two eggs, was seen about 5 m away from the first. Both nests were on a small islet covered with reeds and grass *c.* 4 ha. in area. The nest was a shallow depression, about 8 cm in diameter. The second nest was located inside a circle of stubble. Eggs were broad, oval in shape, pale greyish yellow, blotched black, brown and grey; size *c.* 30 x 24 mm.

Several times another bird, probably the mate of the incubating bird, was trying to distract our attention by displaying a few paces away, quivering its drooped wings, pressing its belly to the ground and uttering sharp *chek chek* calls. A redwattled lapwing *Vanellus indicus* was amicably incubating its eggs about 7 m away from the second nest. The pratincoles chased away cattle egrets *Bubulcus ibis*, brahminy kites *Haliastur indus*, etc. from the nest site, whereas they seemed to tolerate the presence of smaller birds like pipits, larks, warblers, etc.

This is the first record of *G.p. maldivarum* breeding in Kerala.

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9. TIME BUDGETING BY THE SOUTHERN CROW-PHEASANT *CENTROPUS SINENSIS PARROTI* STRESEMANN (AVES : CUCULIDAE) AT PT. CALIMERE, TAMIL NADU

(With a text-figure)

This report covers behavioural activities such as foraging, body maintenance, flying, heavy cover retreat, calling and resting and the time spent on these activities during different hours of the day over a period of one year.

METHODS

At the Kodikkarai village situated on the outskirts of the Pt. Calimere Sanctuary, Tamil Nadu, two pairs of crow-pheasants were followed to record their various behavioural activities. A pair of 8x30 binoculars was used. Data were collected from 0600-1800 hrs and continuous observations were recorded in a data sheet following the focal-animal sampling technique (Altmann 1974). For each month, behavioural activities were recorded for 12 hours during day time. Data were collected from September 1987 to August 1988, covering a total of 144 hours of observations. Since following and watching the bird throughout the day is very difficult, the data were collected in separate sessions of three to four hours each. These periods of data collection were added to give one full 0600-1800 hrs observation period. The monthwise time spent in different activities was calculated and from these values, the percentage time spent for each activity during different times of the day was estimated. From all observations, the total percentage time spent for each activity was calculated. The behavioural activities recorded were as follows:

Food searching, feeding, walking, running, watching, chasing, preening, bill cleaning, head scratching, yawning, ruffling, oiling, wing stretching, leg stretching, body shaking, tail shaking, heavy cover retreat, resting, gliding, flying, walking and hopping, calling and incubating. For data analysis the above behaviour were grouped into seven categories, namely foraging, body maintenance, flying, heavy cover retreat, calling, resting and incubating.

RESULTS AND DISCUSSION

The time spent in various activities by the crow-pheasant during different months during 1987-1988 and percentage of time spent during different hours are given in Fig. 1 and Table 1.

Foraging: Foraging activity includes food search and feeding. Of the total observations the crow-pheasant spent 29.9% of its time in foraging. An increase in foraging activity was noticed in the morning (0600-0900 hrs) and late evening (1600-1800 hrs). The peak foraging activity period was during 0800-0900 hrs (46.2%) and 1700-1800 hrs (41.4%). Early morning and late afternoon peaks in feeding activity (bimodal pattern) are common in many species of birds (Owen 1972, Dwivedi 1976, Frederick and Klaas 1982, Gauthier *et al.* 1988, Paulus 1988, Rajan 1990). The maximum time spent in foraging was recorded in July (401 min.) and the lowest was in December and January, when the birds were incubating.

All figures indicate time spent in minutes per 12 hour observation period.

Body maintenance activities: Maintenance activities "are concerned with locomotion and general health and efficiency of the body" (Marler 1956). The following behaviour were included for analysis in body maintenance activity: preening (wing, shoulder and breast feathers), bill cleaning, bill scratching,

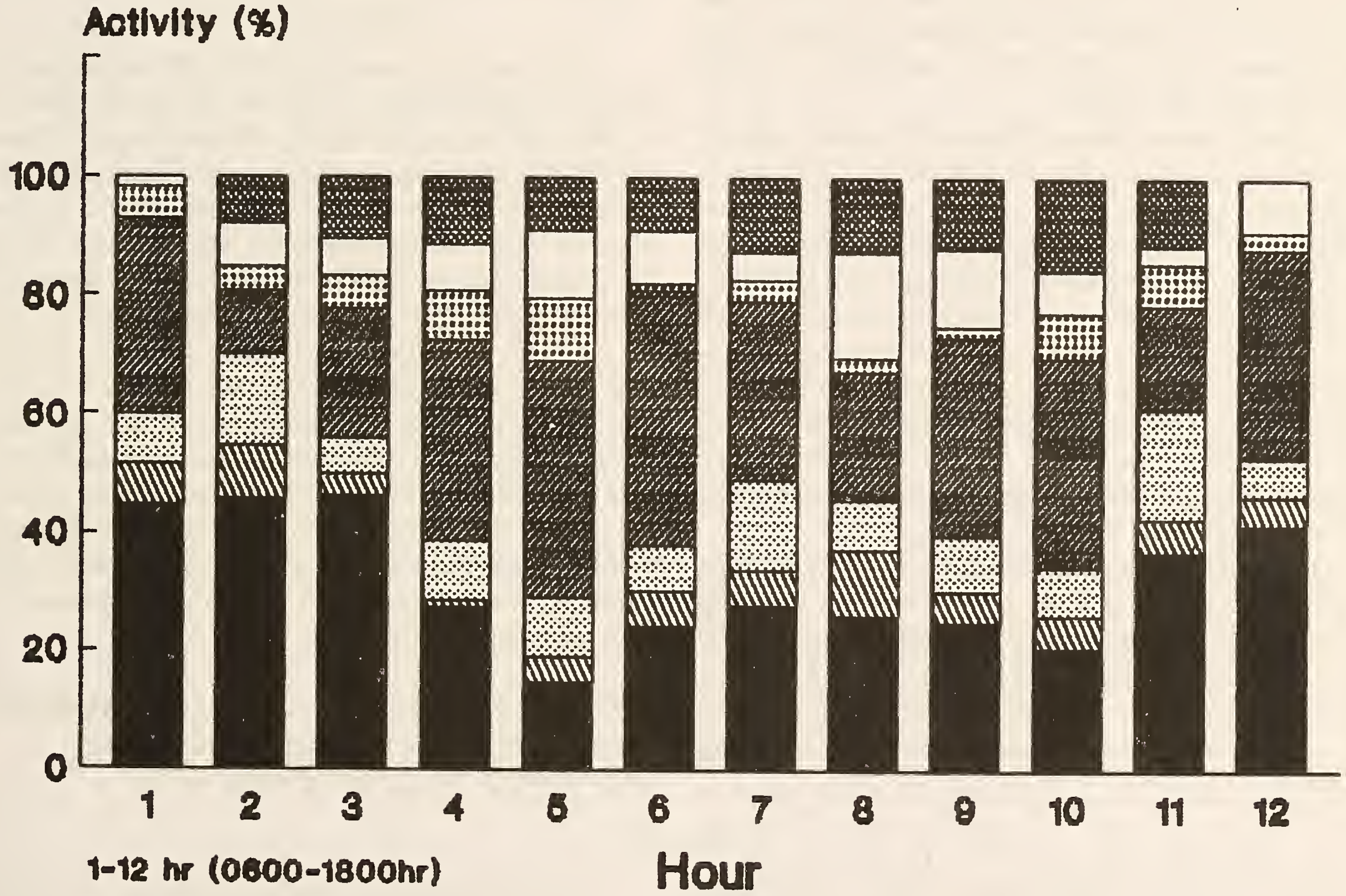

Fig. 1. Percent time spent in activities by the crow-pheasant during different hours.

■ Foraging ▦ Calling ▧ Body maintenance ☐ Resting ░ Flying ▩ Incubation ▨ Heavy cover retreat

TABLE 1

TIME SPENT IN VARIOUS ACTIVITIES BY THE CROW-PHEASANT DURING DIFFERENT MONTHS IN 1987-1988

Activity	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	%
Foraging	297	163	135	30	31	349	334	60	105	293	401	390	29.9
Body maintenance	42	56	44	7	9	9	20	5	8	67	106	106	5.5
Flying	57	30	34	75	22	124	54	5	6	144	133	102	9.1
Heavy cover retreat	158	345	394	94	116	95	270	646	595	154	49	74	34.4
Calling	57	116	79	51	34	18	14	2	3	2	22	23	4.9
Resting	129	10	34	189	34	125	28	2	3	60	9	25	7.5
Incubating	—	—	—	274	474	—	—	—	—	—	—	—	8.7

head scratching, yawning, ruffling, oiling, wing stretching, leg stretching, body shaking and tail shaking.

The bird spent 5.5% of its time in body maintenance, with a peak during 1300-1400 hrs (11.3%). This activity was highest in July and August (106 min.) and lowest in April and May (5, 8 min.).

Flying: The activities included in this category are flying, gliding from a perch and hopping on vegetation. It spent 9.1% of its time in these activities. Flying was common during morning from 0700-0800 hrs (15.4%), afternoon from 1200-1300 hrs (15.2%) and in the evening from 1600-1700 hrs (18.6%). The maximum time spent in flight was during June (144 min.) and the minimum was in April and May (2, 3 min.).

Heavy cover retreat: The bird spent considerable time in retreating into heavy cover, from where it was not visible. It spent totally 34.4% of its time under heavy cover. This is slightly higher than foraging time recorded, but the reverse may well be true if foraging under thick cover could be observed. The peak in this activity was recorded between 1100-1200 hrs (42.7%). The time spent in this activity was high during the hot months of April and May (646 and 595 min.). The mean maximum temperature recorded during these two months was 33.8°C, and 34.5°C respectively.

Calling: The bird spent about 4.9% of its time in calling. Calling was common during early morning and evening. The peak was noticed between 1000 and 1100 hrs (10.6%) during the study. The time spent in this activity was maximum during October (116 min.) before the initiation of the breeding season.

Resting: About 7.5% of its time was spent in resting. This activity was the lowest in the morning (0600-0900 hrs), increased after 0900 hrs and was highest at midday (1300-1400 hrs) (17.5%). The maximum time spent in resting was noticed in December (189 min.).

Incubation: The study pairs spent about 8.7% of their time for incubation. Details of incubation rhythm are given elsewhere. During late December and early January, the pairs spent about 274 min. and 474 min. respectively for incubation.

ACKNOWLEDGEMENTS

This paper is based on my Ph.D. thesis (University of Bombay, 1990). I express my sincere gratitude to my research guide, Mr J.C. Daniel, former Curator, BNHS, for his constant guidance and encouragement. I wish to thank Dr Robert B. Grubh, Mr S.A. Hussain, Dr Asad R. Rahmani, Dr V.S. Vijayan and Mr N. Chaturvedi of BNHS for their help during the study. I gratefully acknowledge the suggestions given by Dr A. J. T. Johnsingh, Deputy Director, Wildlife Institute of India, Dehra Dun. My thanks are due to the U.S. Fish and Wildlife Service for providing funds for the project through the Ministry of Environment and Forests, Govt. of India, and the officials of the Tamil Nadu Forest Department of Pt. Calimere Wildlife Sanctuary for their co-operation and help. I thank S. Karthikeyan and C. Balasubramanian for their assistance in the field.

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10. EXTENSION OF RANGE OF THE KASHMIR ROLLER (BLUE JAY) *CORACIAS GARRULUS* TO GORAKHPUR, UTTAR PRADESH

A bird-aircraft-strike-incident report from Gorakhpur aerodrome (26°45′ N, 83°24′ E) in Uttar Pradesh said that a bird had hit an aircraft at take-off run or climb in or around the aerodrome area on 23 August 1991 between 0845 and 0925 hrs. After detailed examination of the bird strike remnants (feathers) sent to the BNHS, the bird was identified as a Kashmir roller (blue jay) *Coracias garrulus semenowi* Loudon & Tschudi.

The eastern range of this migrant species is recorded up to Lucknow (26°55′ N, 80°59′ E) in Uttar Pradesh (Ripley 1982) and Lakhnad (79°30′ E) in Seoni district of Madhya Pradesh (Ali and Ripley 1983). The bird was probably on its autumn migration which occurs during mid August to early October. The possibilities are either that Gorakhpur lies on the regular migration route of this species or the bird in question is a straggler to the area. A Kashmir roller was also reported to have hit an aircraft in October 1987 over the sea west of Goa during its migration flight at an altitude of *c.* 2424 m during night time (Satheesan 1990).

This data was collected as a part of the work in Bird Hazard Research Cell of the Bombay Natural History Society, sponsored and funded by Aeronautics Research and Development Board of Defence ministry, Government of India.

October 29, 1991 S.M. SATHEESAN
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11. AN INSTANCE OF MATING IN LITTLE SCALYBELLIED GREEN WOODPECKER *PICUS MYRMECOPHONEUS* STRESEMANN FROM BANGALORE

The Kardikal State Forest (*c.* 792 m above msl; 12°42′N, 77°36′E), is a dry-deciduous forest mixed with bamboo *Dendrocalamus strictus* about 35 km south of Bangalore. On the morning of 24 March 1991, while watching birds at Kardikal, our attention was drawn to a long-drawn single syllable call quite similar to that of the rufous woodpecker *Micropternus brachyurus* (Vieillot). As we walked in the direction of the call, we sighted a male scalybellied green woodpecker *Picus myrmecophoneus* Stresemann perched on the branch of a 3 m metre tall *Albizia amara* about 10 m from us.

The bird continued to call for the next five minutes and was joined by a female which perched next to the male. In the next three minutes the female once uttered a call similar to that of the male.

Later the female flew over and alighted on a neighbouring horizontal branch (10 cm in diameter) closely followed by the male. On alighting the female squatted across and crouched low over the branch. The male which had alighted next to the female, sidled up and mounted the female. The male copulated vigorously, gripping the wing bases of the female with its feet and thrashing its wings to maintain balance. The wings of the female drooped low, while the tail of the male was under its belly. The process lasted for about 10 seconds and we presume it resulted in effective coitus. Both birds remained silent during the act.

After the copulation the male flew back to the branch where it was seen earlier and started preening. The pair remained within the canopy of *A. amara* for the next 20 minutes, before flying into the dense canopy of a 10 m tall *Terminalia bellerica* about 40 m away. The mating took place between 1030 and 1110 hrs and within the canopy.

The species has not been seen before in Bangalore.

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12. ACTIVITY-TIME BUDGET OF INDIAN MYNA *ACRIDOTHERES TRISTIS* (LINNAEUS) DURING THE BREEDING SEASON

(With two text-figures)

The Indian myna *Acridotheres tristis* (Linnaeus) is a familiar urban species and a hole-nester. Principally, its breeding season is between April and July. At night, in all seasons they roost communally in large groups.

The activity-time budgets in mynas was studied from 0600 to 1900 hrs from 3 April to 30 June 1978. This study was carried out in Pune, Maharashtra (18°30′N, 73°53′ E) particularly in two residential colonies and the campus of the University of Poona. Solitary and paired mynas were selected randomly and followed till they went out of sight. Their activities were recorded on a tape recorder. Each activity was then measured in seconds and allotted to the following relevant major categories for each hour on a particular day of observation.

The activities were divided into eight major and several sub-categories as: (1) Nesting (billing, mating, bringing nesting material, and sitting at the nest) — presumably for guarding or incubation of eggs and maintenance of nest. (2) Scanning (scanning the environs in general, mouth opening and resting). (3) Locomotion (jumping, hopping, walking and flying). (4) Feeding (food searching, picking of food, drinking and droppings). (5) Calls (flight intention calls, bowing calls, communication calls, alarm calls, aggressive vocalizations and diurnal communal calls). (6) Preening (cleaning or removing of foreign particles from head, neck, body, wings, tail; retaining feathers in condition while sitting). (7) Shaking (shaking of head, body, wings, tail, rubbing of beak after feeding, drinking or preening activity; stretching of legs, and wing flapping while in sitting position). (8) Interactions (jostling during food search or in play,

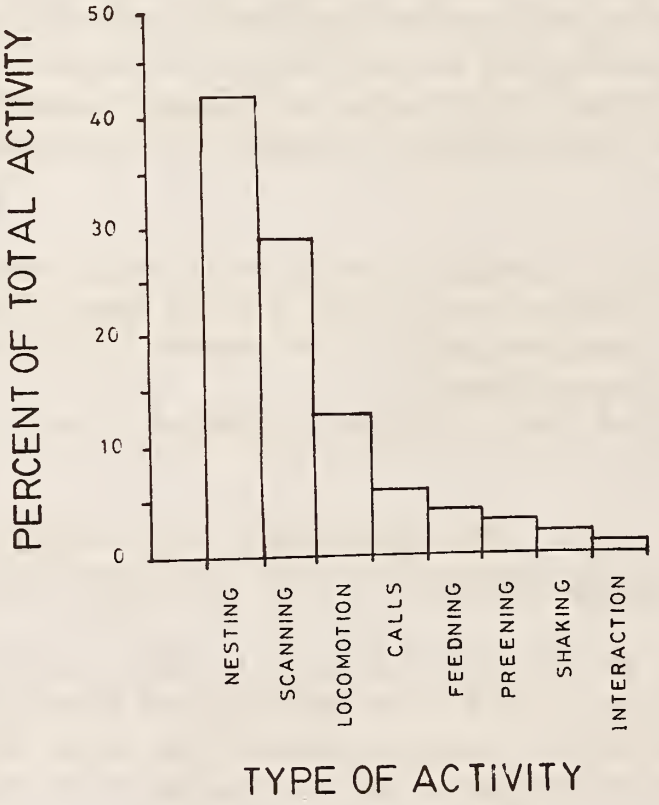

Fig. 1. Comparison of time spent in various activities by mynas during the breeding season.

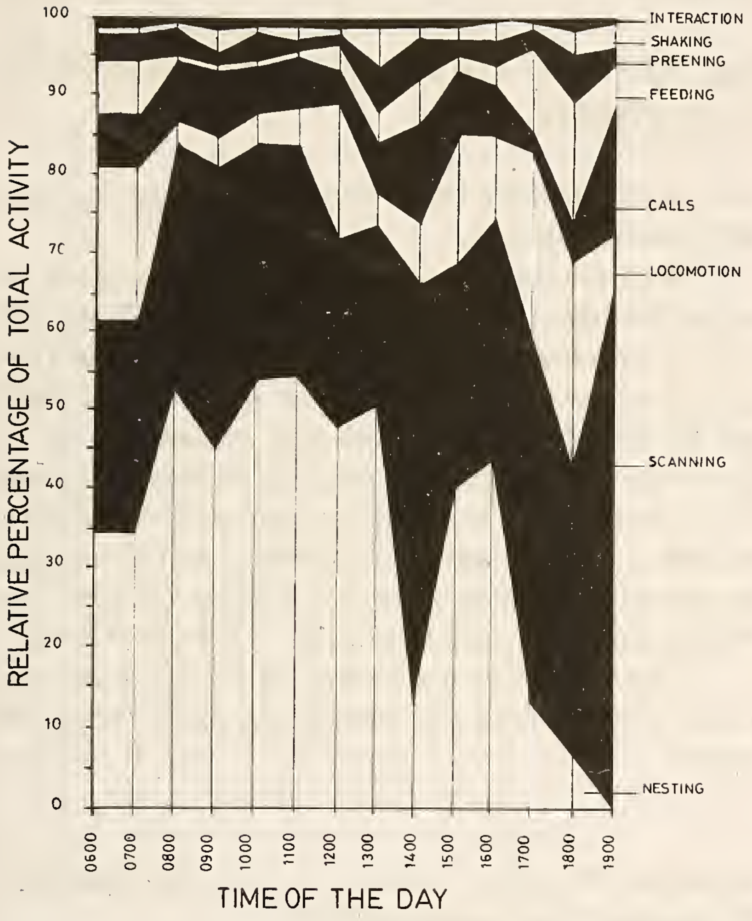

Fig. 2. Activity-time budgets of mynas during different hours of the day.

chasing and interactions with other species of birds).

Data collected for about 74 hours was analysed. The percentage of total time utilised for each major activity was then calculated (Fig. 1). The activity-time budgets for the different hours of the day are shown in Fig. 2. The figures indicate that:

Nesting activity was the predominant activity (42%) during daytime. It decreased slightly in the afternoon between 1300 and 1400 hrs and further declined after 1700 hrs.

Throughout the day mynas were busy in scanning the environs. This was the second most important activity (28%), probably because it relates to anti-predatory behaviour. This activity increased in the morning and in the afternoon between 1300 and 1400 hrs and again after 1800 hrs.

The time spent in locomotion (12%) and in feeding (4%) activities were more or less directly proportional to each other, as locomotion is mainly related with food finding activity. The feeding activity was more in the morning between 0600 and 0800 hrs and in the evening (1700 hrs) well before roosting.

Mynas made various calls throughout the day and spent about 7% of the total time calling. This activity was relatively higher in the morning around 0900 hrs, then in the afternoon between 1300 and 1400 hrs and late in the evening after 1800 hrs. This activity thus seems to be closely related to scanning.

The remaining activities such as preening (3%), shaking (2.5%), and mutual interactions (1.5%) took considerably less time as compared to the other major activities. Preening activity slightly increased (along with scanning) in the afternoon and late in the evening.

The exact time spent in resting activity during daytime was rather difficult to assess, but at night mynas sleep at the communal roost. Time spent in such communal roosts varies monthly and depends upon the time of sunset and sunrise. The total time spent in sleep during the study period was estimated as about 695 min. in April, 655 min. in May and 640 min. in June 1978.

The nesting activity was the highest as anticipated since the study period coincided with the peak breeding season. Further, it would be interesting to study the time-budgets of laying, incubation, brood development separately by males and females; and also the various activities performed during the non-breeding season.

December 7, 1991 ANIL MAHABAL

Zoological Survey of India, High Altitude Zoology Field Station, Solan, Himachal Pradesh 173 212

13. BREEDING RECORD OF FERRUGINOUS FLYCATCHER *MUSCICAPA FERRUGINEA* (HODGSON)

The ferruginous flycatcher *Muscicapa ferruginea* was often seen during my visit to Talley valley in Lower Subansiri district, Assam, from 19 June to 24 June 1991. The sightings were made at altitudes varying from *c.* 1525 m to *c.* 2135 m in darker areas in temperate broad leaved forests. At one place two young ones were seen perched on a twig adjacent to each other. These birds were being fed by two other birds (parents) who made frequent sallies for insects. The above fact proves that the ferruginous flycatcher breeds in Talley Valley area.

November 12, 1991. PRATAP SINGH
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14. DARK GREY BUSH CHAT *SAXICOLA FERREA* GRAY IN RAJASTHAN AND MADHYA PRADESH

On 24 December 1985, I recorded a lone female dark grey bush chat *Saxicola ferrea* at the Great Indian Bustard Sanctuary at Karera (Shivpuri district, 25° 30′ N, 78°5′ E), Madhya Pradesh. The bird was readily identified owing to my familiarity with the species at Keoladeo National Park in Bharatpur (27°13′ N, 77°32′ E), Rajasthan, where I had observed a parochial female almost every day in the latter half of January 1984. On both the occasions, the habitat was the edge of a grove of trees and the bird was seen perched exposed on tips of shrubs of the undergrowth. Both sightings were corroborated by a number of BNHS researchers who were stationed in the respective areas at the time.

The bird could be easily mistaken for a small shrike in appearance and demeanour. They frequently swooped down to the ground from their bush-top perch to capture prey and returned to the thickets. They were tame and allowed close approach. The white throat and the dark brown mask were the most conspicuous features.

Both the records are possibly new ones for the respective sanctuaries. Ali and Ripley (1987) say that the bird winters "down to the foothills into the Gangetic plain south to the Yamuna river ...." Abdulali and Panday (1978) question the occurrence of the bird in the Delhi area, and omit it from the Bharatpur list. The species, however, is not new to Madhya Pradesh state. Newton *et al.* (1986) report seven sight records of the species for the winters of 1981 and 1982 at Kanha National Park (22 °17′ N, 80 °38′ E).

I thank the late Dr Salim Ali for his comments on the observations and prompting me to write this note.

December 17, 1991 R. KANNAN
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15. UNUSUAL NESTING SITE OF HOUSE SPARROW *PASSER DOMESTICUS* (LINN.) IN HYDERABAD

On 8 March 1991, while birdwatching in Jubilee Hills, Hyderabad, we located a nest of the common pariah kite *Milvus migrans govinda.* The nest was constructed on an electricity pylon *c.* 10 m above ground and one of the kites was seen sitting on the nest. Owing to the inaccessibility of the nest, we could not see if it was occupied by young, but the pair of adult kites were making frequent trips to the nest and were sitting on nearby pylons keeping a watchful eye on us and the nest.

Under the structure of the kites' eyrie, we saw the nest of a house sparrow *Passer domesticus.* The sparrow's nest was cleverly woven into the underside of the kite's nest. The sparrows evidently had young in their nest because we observed the adults bringing insects to the nest and also heard the cheeping of the chicks from inside the nest.

HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (Ali, S. and Ripley, S.D. 1987) makes no reference to a nesting site of this nature for any species of sparrow.

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October 22, 1991 HUMAYUN TAHER[2]
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16. RECORDS OF PREDATION ON BIRDS TRAPPED IN MISTNETS

On 22 January 1990 at about 1715 hrs, during mist netting we came across a whitebreasted kingfisher *Halcyon smyrnensis*, feeding on a female Indian robin *Saxicoloides fulicata*, which was trapped in one of our mistnets. The mistnets were spread out in *Salvadora persica* and *Prosopis chilensis* scrub around Fulay village, district Kutch, Gujarat. This particular net was located close to the village pond, where the kingfisher had a regular perch. The kingfisher was on the ground, repeatedly jumping and pecking at the robin, which was trapped in the lowest shelf of the mistnet.

By the time we reached the net, the kingfisher had mauled the robin badly by repeated pecks on its skull and neck, and the robin had succumbed to the injuries. We left the dead bird in the net to see whether the kingfisher would return to its prey. As soon as we took cover behind a bush, the kingfisher returned and started pecking at the dead robin. It helped itself to small pieces of the flesh and finally managed to detach the head and neck, and flew off with a small portion. Perhaps our presence disturbed it, and it did not return to the net again.

This is the first instance of a whitebreasted kingfisher eating an Indian robin. Similar instances during mistnetting are frequently recorded by mistnetters. We have seen coucal *Centropus sinensis* killing trapped birds on two separate occasions. During the present mistnetting session, a house crow *Corvus splendens* and a shikra *Accipiter badius*, were trapped as they followed a whitecheeked bulbul *Pycnonotus leucogenys* and a rosy pastor *Sturnus roseus* respectively, which were entangled in our mistnet.

On another occasion, we observed a small Indian mongoose *Herpestes edwardsi* killing a female Indian robin which was trapped in the lowest shelf of the mistnet. The mongoose was probably following our activities and as soon as a bird was trapped it rushed to the net and killed it. On our approach it scampered into the nearby *Prosopis chilensis* bushes, leaving the badly mangled robin in the net.

In all instances, only those birds which get trapped in the lowest shelf of the mistnets, fall victim to predators such as mongooses and coucals. However, shikras, crows and other predatory birds like shrikes, follow trapped and fluttering birds in the mistnets. In one instance in Pt. Calimere (Thanjavur district, Tamil Nadu) one of us (SAA) saw a cobra *Naja naja*, which had positioned itself near a bird trapped in the lowest shelf of a mistnet; it crawled into the nearby bushes on our approach. Crow-pheasants have been reported feeding on small birds caught in low mistnets (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Ali, S. and Ripley, S.D. 1983). Rails have also been reported preying similarly on birds caught in mistnets.

The possibility of trapped birds being preyed upon by other birds, mammals and probably reptiles should be considered before a site is selected for mistnetting. This will help in avoiding casualties during mistnetting operations. Moreover, there have been instances when birds which have been removed from mistnets and kept in net bags in isolated spots, have been killed by predatory birds/mammals in the area.

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17. MIXED-SPECIES FLOCK COMPOSITIONS IN TWO FOREST TYPES IN BANGLADESH

Mixed-species flocking in the non-breeding season has been reported for a wide range of avian taxa. Commonly hypothesized functions of such aggregations have typically fallen into two categories: foraging benefits (Morse 1970, 1978; Krebs 1973, MacDonald and Henderson 1977), and enhanced anti-predator detection (Buskirk 1976, Powell 1985). Foraging benefits include disturbances caused by flock members that serve to flush insects from foliage (MacDonald and Henderson 1977) and reduction of niche overlap that leads to weaker competition between species participating in mixed-species flocks (Austin and Smith 1972). These functions are not mutually exclusive, and probably vary not only between species but also between age and sex classes within each species.

Mixed-species flocking is especially characteristic of tropical and subtropical forest birds, and considerable field research on the phenomenon has been done in the neotropics (Powell 1979) and in south-east Asia (McClure 1967). However, little systematic observation has been made of mixed-species flocks in the Indian subcontinent. Partridge and Ashcroft (1976) studied mixed-species associations in montane forest in Sri Lanka, Stanford (1947) noted mixed-species flocking in Burmese forests, and MacDonald and Henderson (1977) studied the phenomenon in Kashmir. No previous systematic studies have been made on mixed-species flocking in the eastern subcontinent.

In this paper I report on the compositions of mixed-species bird flocks in both moist deciduous and wet semi-evergreen forest in Bangladesh. The observations reported here also represent one of the few field studies made of the occurrence and behaviour of forest birds in Bangladesh. Haque (1982) has compiled a bird list for Madhupur National Park, and the birds of the area have been surveyed periodically, but several new records for the moist deciduous belt in northern Bangladesh emerged from the present study.

STUDY SITE AND METHODS

Data were collected during field work in two forest types in Bangladesh. The field work was conducted from September to December 1986 and from December 1987 to December 1988. A flock was constituted by a distinct foraging group of birds, which remained intact as the birds travelled through the forest. Observations of mixed-species flocking in moist deciduous forest were made in Madhupur National Park in north-central Bangladesh, and in wet semi-evergreen forest in Kalenga and Banugach Reserve Forests in north-eastern Bangladesh, near the town of Srimangal. These forest type assignments are based on Puri (1960). Madhupur National Park is comprised mainly of deciduous forest, such that during the period of observation (November through March), there were few leaves on most tree species, visibility was excellent, and stationary food resources (fruit, leaves, seeds, flowers) were scarce. Most of the species whose behaviour is described below are predominantly insectivorous.

Observations at Madhupur were made on an *ad libitum* basis throughout the course of 15 months of field research there. Observations of flocking associations in north-eastern forests were made during surveys there in October 1986 and October-November 1988. I walked forest transects during surveys, noting all mammals and birds visible or audible from the trail, and followed mixed-species flocks detected from the transect through the forests to determine their composition and spatial distribution. Flocks were followed for some distance through the forest, sometimes but not always until they dispersed. During these follows, scan data on flock composition and feeding behaviour were recorded at 10-minute intervals. All bird species observed in mixed-species aggregations are listed in Table 1. Additional observations of mixed-species flocks were made on birding trips with Dr David Millen of the Bangladesh Tea Research Institute in Srimangal.

COMPOSITION OF MIXED-SPECIES FLOCKS

A total of 25 species were recorded in multi-species assemblages in the moist deciduous forest of Madhupur National Park (Table 1). In wet semi-evergreen forest, 27 species were recorded, though the total number of sightings of mixed-species foraging flocks was lower in wet semi-evergreen forest (17) than in moist deciduous forest (65). At Madhupur, where field work was being carried out on a year-round basis, multi-species associations were noted only between mid-October and early March.

The composition of mixed-species flocks differed between the two forest types in general relation to the difference in overall species composition of the two forest types. The composition of species in such flocks also varied between flocks and from day to day in each site (Table 2). Some of the most abundant fruit-eating species at Madhupur, such as lineated barbet *Megalaima lineata* and blackheaded oriole *Oriolus xanthornus*, did not associate in mixed species flocks during the non-breeding season. The species that occurred in mixed-species assemblages were, as in other geographic regions, mainly insect-eating species. Some insect-eating species, however, did not appear to associate with multi-species flocks; scarlet minivets (*Pericrocotus*), for instance, did not join such flocks, although other wintering minivet species (*P. roseus* and *P. brevirostris*) did so.

The assemblages in both forest types included many species that are known only as winter residents in Bangladesh, such as the leaf-warblers *Phylloscopus* spp. Of the 25 species recorded in multi-species flocks at Madhupur, three are woodpeckers (Picidae); in wet semi-evergreen forest at least six species of picid (four woodpeckers plus two piculets)

TABLE 1
COMMON AND SCIENTIFIC NAMES OF BIRD SPECIES

Common name	Scientific name
Threetoed goldenbacked woodpecker	*Dinopium shorii*
Lesser goldenbacked woodpecker	*Dinopium benghalense*
Large yellownaped woodpecker	*Picus flavinucha*
Small yellownaped woodpecker	*Picus chlorolophus*
Blacknaped woodpecker	*Picus canus*
Greycrowned pygmy woodpecker	*Dendrocopos canicapillus*
Velvetfronted nuthatch	*Sitta frontalis*
Rufous piculet	*Picumnus innominatus*
Great tit	*Parus major*
Large racquet-tailed drongo	*Dicrurus paradiseus*
Small racquet-tailed drongo	*Dicrurus remifer*
Haircrested drongo	*Dicrurus hottentottus*
Ashy drongo	*Dicrurus leucophaeus*
Bronzed drongo	*Dicrurus aeneus*
Grayheaded myna	*Sturnus malabaricus*
Gray tree pie	*Dendrocitta formosae*
Rosy minivet	*Pericrocotus roseus*
Shortbilled minivet	*Pericrocotus brevirostris*
Common iora	*Aegithina tiphia*
Nepal babbler	*Alcippe nipalensis*
Yellowbreasted tit-babbler	*Macronous gularis*
Jungle babbler	*Turdoides striatus*
Spotted babbler	*Pellorneum ruficeps*
Large necklaced laughing-thrush	*Garrulax pectoralis*
Lesser wood-shrike	*Tephrodornis pondicerianus*
Bluenaped monarch	*Monarcha azurea*
Greyheaded flycatcher	*Culicicapa ceylonensis*
Large crowned leaf-warbler	*Phylloscopus occipitalis*
Plain leaf-warbler	*Phylloscopus inornatus*
Crowned leaf-warbler	*Phylloscopus reguloides*
Tickell's leaf-warbler	*Phylloscopus affinis*
Brown leaf-warbler	*Phylloscopus collybita*
Little spiderhunter	*Arachnothera longirostris*
Whitebellied yuhina	*Yuhina zantholeuca*
White-eye	*Zosterops palpebrosa*
Redwhiskered bulbul	*Pycnonotus jocosus*
Redvented bulbul	*Pycnonotus cafer*
Large greenbilled malkoha	*Rhopodytes tristis*
Drongo cuckoo	*Surniculus lugubris*

foraged together regularly. In the latter case the piculets tended to forage closer to the ground than did the woodpeckers.

These preliminary observations of multi-species associations in Bangladesh forests show that in both moist deciduous and wet forests the association of multiple species for foraging during winter months is an important component of the bird community. In a deciduous forest such as Madhupur, the period during which some bird species forage in association coincides with the period of least rainfall and probably least food availability (Stanford in press). One could argue that small insect-eating birds could maximise access to food sources by banding together opportunistically to capitalise on the food-finding abilities of other members of the flock. The food

TABLE 2
COMPOSITION OF SPECIES RECORDED IN MIXED SPECIES-FLOCKS IN MOIST DECIDUOUS AND WET SEMI-EVERGREEN FOREST IN BANGLADESH

Species	Moist deciduous (n=65)	Wet semi-evergreen (n=17)
Dinopium shorii	10.8	5.9
Dinopium benghalense	93.8	NR
Picus flavinucha	NR	17.6
Picus chlorolophus	NR	23.5
Picus canus	—	29.4
Dendrocopus canicapillus	6.2	NR
Sitta frontalis	15.4*	—
Sasia ochracea	NR	17.6
Picumnus innominatus	NR	17.6
Parus major	92.3	—
Dicrurus paradiseus	1.5*	47.1
Dicrurus remifer	21.5*	23.5
Dicrurus hottentottus	90.8	5.9
Dicrurus leucophaeus	9.2	—
Dicrurus aeneus	7.7	—
Sturnus malabaricus	35.4	—
Dendrocitta formosae	NR	5.9
Pericrocotus roseus	3.1*	NR
Pericrocotus brevirostris	13.8	NR
Aegithina tiphia	61.5	64.7
Alcippe nipalensis	NR	58.8
Macronous gularis	NR	35.3
Turdoides striatus	52.3	—
Pellorneum ruficeps	—	11.8
Garrulax pectoralis	NR	58.8
Tephrodornis pondicerianus	50.8	NR
Monarcha azurea	44.6	94.1
Culicicapa ceylonensis	10.8	47.1
Phylloscopus occipitalis	3.1	NR
Phylloscopus inornatus	33.8	35.3
Phylloscopus reguloides	7.7	5.9
Phylloscopus affinis	15.4	5.9
Phylloscopus collybita	15.4	—
Arachnothera longirostris	NR	17.6
Yuhina zantholeuca	NR	29.4
Zosterops palpebrosa	16.9	76.4
Pycnonotus jocosus	7.7	17.6
Pycnonotus cafer	—	5.9
Rhopodytes tristis	NR	11.8
Surniculus lugubris	NR	5.9

Figures show percentage of flocks in which each species was recorded.
NR = Species not recorded in that forest type, * = first record of species in Madhupur National Park.

niche of a large woodpecker such as *Dinopium shorii* is, however, sufficiently different from that of a leaf-warbler or small flycatcher that such a food- finding benefit would probably not extend to all members of a multi-species flock.

That up to six woodpecker species of varying sizes forage together in the wet forest zone of Kalenga and Banugach may be explainable in terms of similar food requirements and a mutual benefit to flock members in searching for food. Why these woodpeckers associate so regularly with small passerines is not clear. Most woodpecker species are non-migratory, occupy small home ranges and are highly territorial (Short 1982). If home ranges of individuals or pairs of woodpeckers are smaller than the average home range size of the mixed-species flock in which they participate, then it would be expected that there would be a high flock member turnover rate as the flock sweeps across the territories of resident birds. Other South Asian forests contain diverse assemblages of both piciform and passerine birds; the form and function of multi-species assemblages is a subject requiring much field research.

ACKNOWLEDGEMENTS

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June 17, 1991 CRAIG B. STANFORD
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18. AWAKENING TIME OF BIRDS IN RELATION TO SUNRISE

(With four text-figures)

In the winter of 1986 I decided to observe the awakening time of various species of birds found in the Civil Lines, Kota (25°10′ N, 75°48′ E), where I lived. Though Kota is a very polluted city, the part of Kota where I lived was comparatively better vegetated, being a part of the palace of the former rulers of Kota. My study area was roughly 800 m long, which I used to walk at an easy pace thrice every morning.

The study area had a large variety of trees and shrubs such as *Ficus religiosa, Ficus glomerata, Capparis* sp., *Syzygium cumini, Cordia myxa, Acacia nilotica, Prosopis chilensis Lantana* sp. and *Lawsonia inermis*. Fruits of many of these species were eaten by birds and some trees were used for nesting. There was ample food for insect-eaters. The area also had a small irrigation canal which frequently inundated some low-lying patches, thus attracting species such as kingfishers, wagtails and pipits. There were a large number of beehives in the area attracting honey buzzards. Annual average rainfall of Kota is approximately 650 mm.

METHODS

I kept notes on all the birds of my study area, their movement, first and last sightings of migratory species, breeding cycle of resident birds and their roost sites and roosting behaviour. Every day the time of the first call or first sighting of a particular species (whichever was earlier) was recorded as the awakening time for the species on that day. In the majority of cases, observations were based on calls and not on actual sightings. The awakening time of most birds is at least 10 minutes before sunrise. It was often difficult to identify birds positively by sight in the dim light, but easier to do so from the call.

It is also assumed that immediately after rising most birds do call and that almost all individuals of a species in a particular locality wake up almost simultaneously. As the area was rich in vegetation, the number of birds were high enough and well spread out, so that I generally heard the first call or saw the bird whenever I was at that time in the study area.

The awakening time of 23 species of birds was observed for two years, September 1986 to August 1988, almost every day. Sunrise time was noted from the local newspaper (Figs. 1 and 2). Data for the period September 1987 to August 1988 were plotted at approximately 10 day intervals. However, if at this interval the day was very cloudy or foggy available data of the nearest normal day were used.

RESULTS AND DISCUSSION

It was observed that all birds wake before sunrise. During the breeding season (summer) some birds rise much earlier in relation to sunrise than at other times of the year.

There appears to be a more or less definite sequence in which different species of birds awake, particularly during the general breeding period (April-July). During this period generally the black drongo is the first to rise, followed by house crow, koel, magpie-robin, crow-pheasant, bulbul, Indian robin, ring dove, myna, babbler, Franklin's warbler, partridge, parakeets, tailor bird, iora, barbet and purple sunbird. During winter the sequence seems a little changed, which may partly be ascribed to some birds calling very rarely and late though they may be up and active much earlier, e.g. black drongo, iora, paradise flycatcher etc.

On very cloudy or foggy days birds generally called late. In case of colonial roosters like house crows, parakeets etc. I had observed only passage to foraging grounds and this was delayed on such days.

The largest variation in the awakening time was seen in the case of black drongo *Dicrurus adsimilis* (Fig. 1). Though from mid-September to mid-March it used to wake 10-15 minutes before sunrise, from mid-May to mid-July it started awakening 90 to 120 minutes earlier than sunrise. It was noticed to sing more during courtship and up to egg laying stage, and sometimes during the incubation period also. After the eggs hatched, its singing was reduced.

In the case of the koel *Eudynamys scolopacea* also, a large variation was seen in the awakening time (Fig. 2). During November and December, it was heard approximately 15 minutes before sunrise, from January to May about 25 minutes and from June to mid-July as early as 60 minutes before sunrise. This early awakening also coincided with the breeding period.

The magpie-robin *Copsychus saularis* awakes 15 to 20 minutes before sunrise in February-March and September-October (Fig. 2). From November to January, it awakes approximately 30 minutes before sunrise, and during April to June, which is its breeding season, it wakes 50 minutes before sunrise.

The house crow *Corvus splendens* is a consistent early riser (Figs. 1, 3) and wakes 35 to 45 minutes before sunrise. Although they start calling and shifting positions in their roosting colonies much earlier, even when it is dark, I recorded them as awake only when I saw or heard them leaving their roosting sites for foraging. Similarly, colonial roosters such as house sparrows *Passer domesticus* and common myna start calling early, in their respective roosts, but leave the roosting sites only 15 to 20 minutes before sunrise. The roseringed parakeet *Psittacula krameri* also roosts in colonies where it starts calling much before it flies. It was found to be very punctual in relation to sunrise time (Figs. 2, 4) throughout the year in leaving the roosting sites. The redvented bulbul *Pycnonotus cafer* is also a very consistent riser, awakening 25 to 30 minutes before sunrise (Figs. 1, 3). However, during June and July, I saw it awaken slightly earlier than in other months.

The coppersmith *Megalaima haemacephala* is a steady late riser (Figs. 2, 4), getting up only 5-10

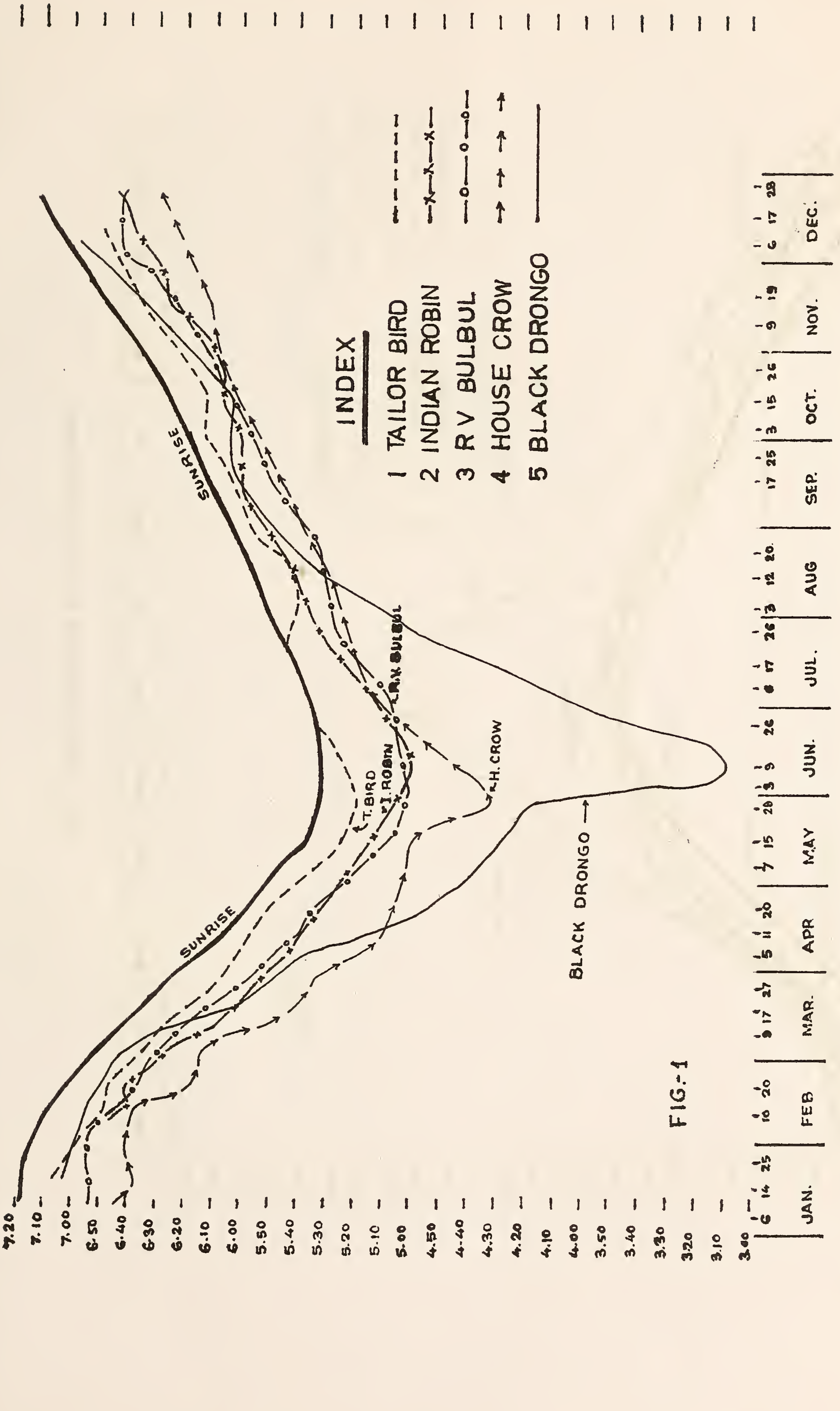

Fig. 1. Awakening time of birds in relation to sunrise.

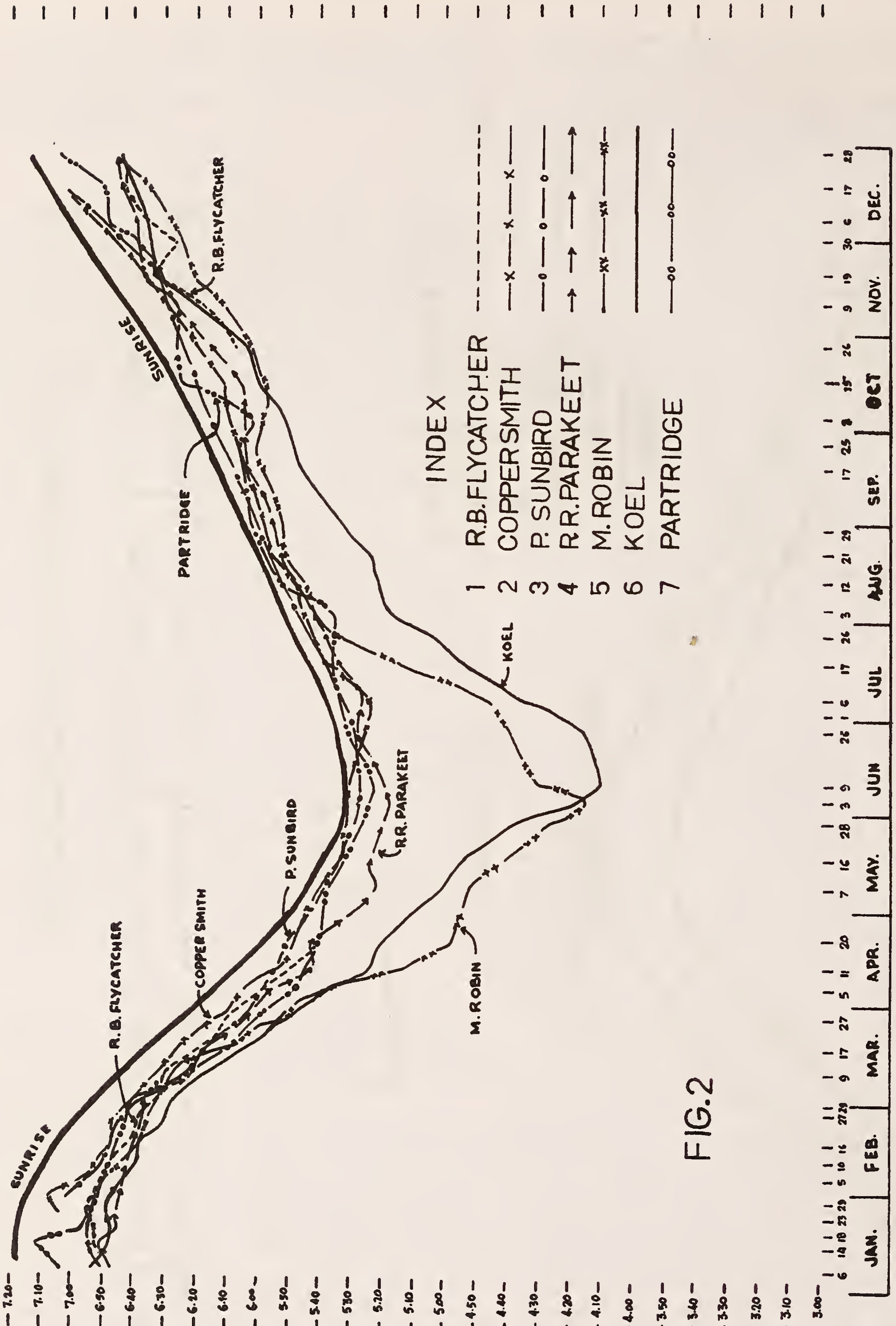

FIG.2

Fig. 2. Awakening time of birds in relation to sunrise.

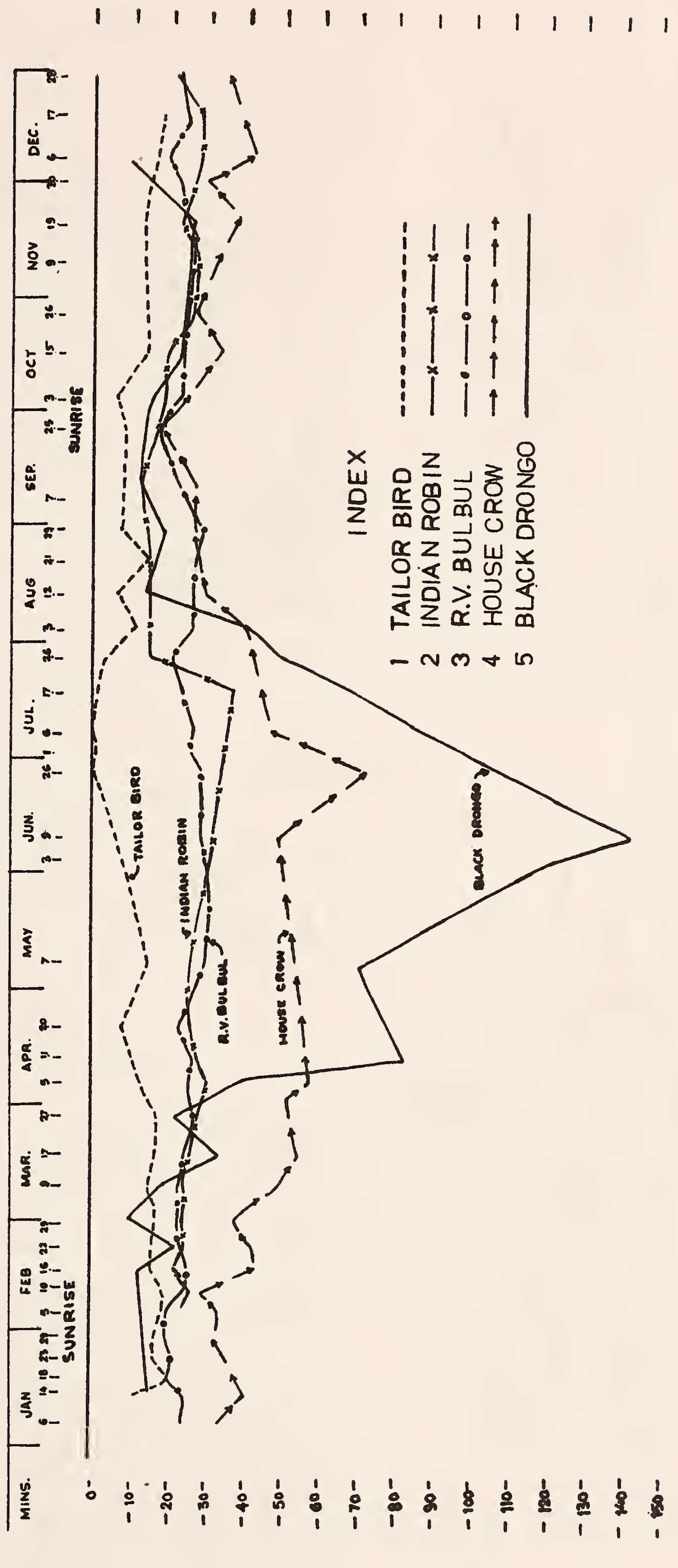

Fig. 3. Time of first call of different species of birds, in relation to sunrise.

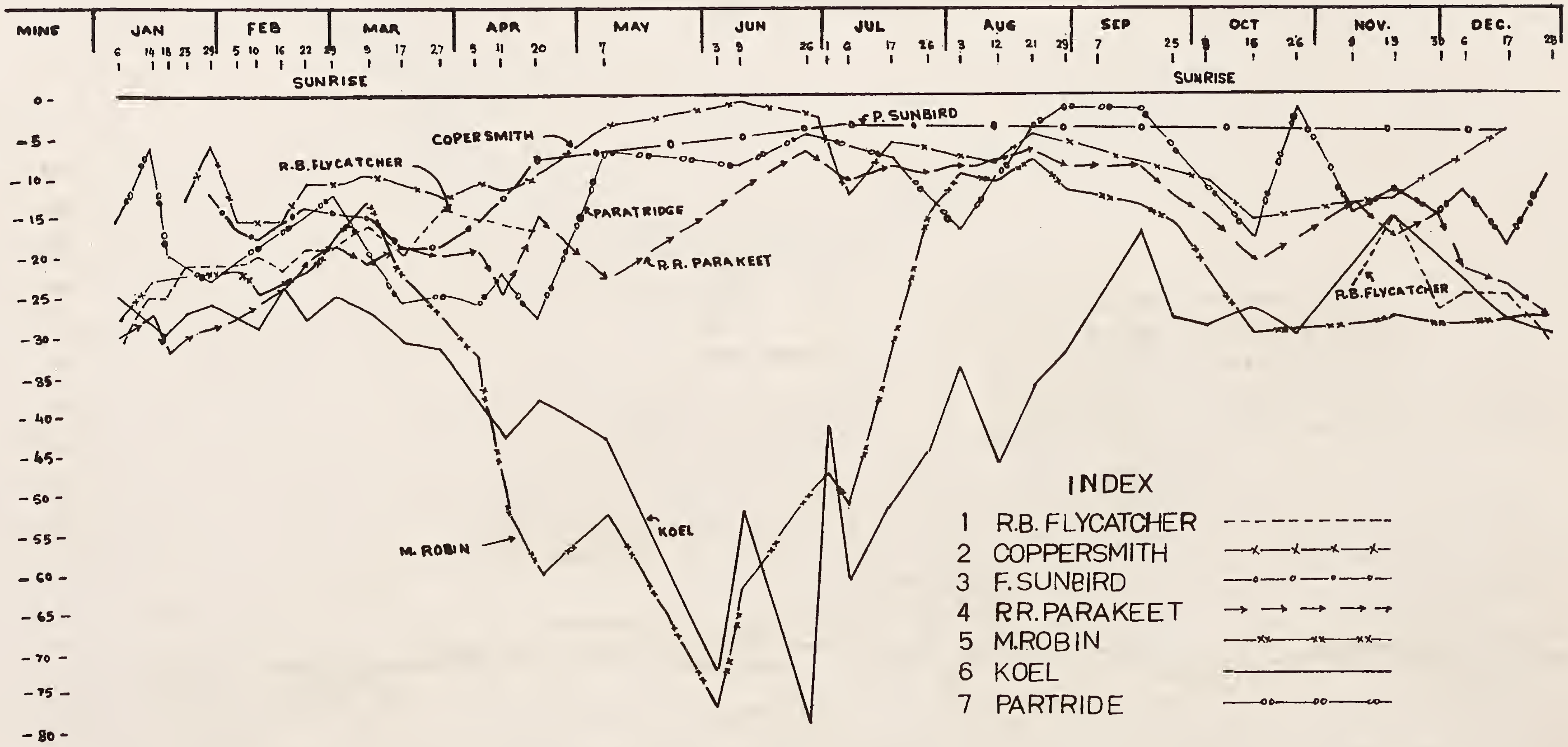

Fig. 4. Time of first call of different species of birds, in relation to sunrise.

minutes before sunrise. Franklin's warbler *Prinia hodgsonii* rises roughly 20-25 minutes earlier than sunrise. The ring dove *Streptopelia decaocto* is an early riser, generally rising 25-30 minutes before sunrise, and during summer 40 minutes before sunrise. I also heard occasional calls of the ring dove at very odd hours in the night, particularly on moonlit nights.

Between October and February, the crow-pheasant *Centropus sinensis* was heard 8-15 minutes before sunrise but in April and May it called much earlier — nearly 40 minutes before sunrise. After this period, it came to the level of 10 minutes by October.

When it rained, or on cold and foggy mornings in winter, the rising time was somewhat late. The same thing was noticed during winter on severely cold and foggy mornings. However, in general the sequence and rising time of various species could be predicted to almost ± 2 minutes. Even in the evening, a definite sequence was observed in the 'retiring' times or the time at which the last call of a species was heard. Among the early roosters are the purple sunbird *Nectarinia asiatica*, tailor bird *Orthotomus sutorius* and coppersmith. These birds also happen to be late risers. Among the late roosters are the black drongo, redvented bulbul and magpie-robin. Interestingly these birds are early risers.

The awakening time in relation to sunrise (which was taken as zero) is shown in Figs. 3 and 4. These figures show the general sequence in which different species of birds started calling, and also generally indicate the breeding period of a species in that region. Evidently, birds become more active and start calling or singing more and earlier during their courtship and breeding period. For example, at Kota, the breeding period for black drongo, as seen from the sharp dip in Fig. 3, is from March to August. Similarly for the Indian robin it is May to July. Fig. 4 indicates that breeding periods for magpie-robin, koel, roseringed parakeet, purple sunbird and barbet are April to July, April to September, January to June, February to June and January to May respectively. The dip seen in October-November may be ascribed to rise in temperature and climatic conditions similar to those in spring, which may be inducing birds to call earlier. It will be interesting to examine whether Figs. 3 and 4 indicate the general pattern for all areas in the central Indian plains on normal clear days. In hilly tracts it may vary because different aspects of hills reach the same level of brightness at different times.

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19. CAPTIVE BREEDING OF THE INDIAN ROOFED TERRAPIN *KACHUGA TECTA* (GRAY)

(With a plate)

INTRODUCTION

The Indian roofed terrapin *Kachuga tecta* (Gray, 1831) is one of the poorly known Indian testudines. This species is widely distributed in India except in peninsular India, Pakistan, Bangladesh and Nepal (Moll 1987). This omnivorous terrapin inhabits ponds, puddles, tanks, *nallahs* and other water bodies such as roadside ditches, slow running rivers and streams.

Exact population figures for *Kachuga tecta* are not available but the number has been reduced drastically due to reasons such as (1) Use of eggs and adults as food by tribals, (2) Destruction of nesting grounds by removing sand for commercial use and use of sand beds for seasonal cultivation, (3) Destruction of habitat by industrial projects and (4) Water pollution. Egg predation and climatic changes are also responsible for population decline.

There is not much literature available on this species, especially on its breeding biology. Vijaya (1982) summarised the breeding data as six nests at river bed during the month of December, clutch size 4-8, egg size 40-45 x 26-29 mm, weight 12-18 g, incubation period 125-144 days and nest 15-26 cm deep. Mishra (1984) observed nesting in the month of October at Chambal Sanctuary, Madhya Pradesh. Moll (1987) observed eight eggs in January of 37x21 mm size, 7.5-10.0 g weight from one nest.

This species is protected by legislation under Indian Wildlife Protection Act 1972, amendment 1986 as belonging to Schedule I. The species is listed in CITES - Appendix I and also mentioned as an Interminate category in the IUCN Red-Data Book.

Our study on its captive breeding was undertaken from March 1989 to July 1991 to get further information about its breeding to support the species establishment for restocking in zoos.

MATERIAL AND METHODS

Eight terrapins, three males and five females, were introduced into a breeding enclosure. Males were identified by smaller size, being more active and brighter in colour than the females. Males have a thicker and longer tail than females. The male-female ratio is 1:2 by body size and 1:9 by weight. The captive terrapins were fed on aquatic vegetation and coriander leaves. Air and nest temperatures were recorded thrice a day at 0900, 1500 and 1800 hrs. The clutch and egg size, date of laying, incubation period and measurements of hatchlings were recorded.

The breeding enclosure was a rectangular tank of 4 x 4.5 m with a 50 cm high peripheral wall. In the centre of the enclosure, a sloping pool of 1.5 x 1.5 m area and 0.5 m depth was prepared. The soil in the enclosure was mixed with 50% sand to prevent it from becoming too hard. The entire enclosure was furnished with stones and plants to resemble natural habitat and the top was covered with wire mesh for protection against predators.

OBSERVATIONS

Male terrapins developed a small tubercle at the end of the thick tail during October, just before the breeding season, and shed it during March. One male was observed to have the tubercle throughout the year. It is believed to help in mating, especially in probing the cloacal opening of the female. No colour change in male or female was observed during the breeding season. The male courted the female by side to side swimming and also circling the females. Actual mating was not observed during the study period, but it is believed that mating takes place at bottom of the pool.

Nesting behaviour: Nesting behaviour was observed in February and March 1991, when four females prepared their nests. Their behaviour was similar, except that one female laid eggs and thereafter returned to the water without covering the nest. The female came out of water between 1500 and 1800 hrs and selected a suitable place, 6 to 45 cm away from the pool. Excavation of the pit was done with the help of both the hind limbs, used alternately. Three to four hours were required for excavation of the complete nest. After excavation of the nest chamber, the first egg was laid in 4 to 30 minutes and the subsequent eggs were laid at intervals of 30 to 90 seconds. The egg laying process took nearly 8 to 10 minutes of which 3 to 8 minutes were spent in arranging the eggs with the hind limbs. After arranging the eggs, the nest was covered by the excavated soil, again using the hind limbs.

Camouflaging the nest took 4 to 6 hours. Nests ranged from 14 to 20 cm in depth and 10 to 12 cm in width with a narrow entrance.

Clutch and egg size: During 1990 only one out of the five females laid three eggs on the bottom of the pool. During 1991 four females laid 7, 9, 10 and 5 eggs each (Table 1). The eggs were white in colour, elongated, capsule-like with both the poles equally rounded. The average egg measured 4.29 cm in length and 2.32 cm in width.

Hatching: The eggs started to hatch in nest 1 after 70 days and in nest 2 after 78 days of incubation. Eggs in nests 3 and 4 did not hatch. The

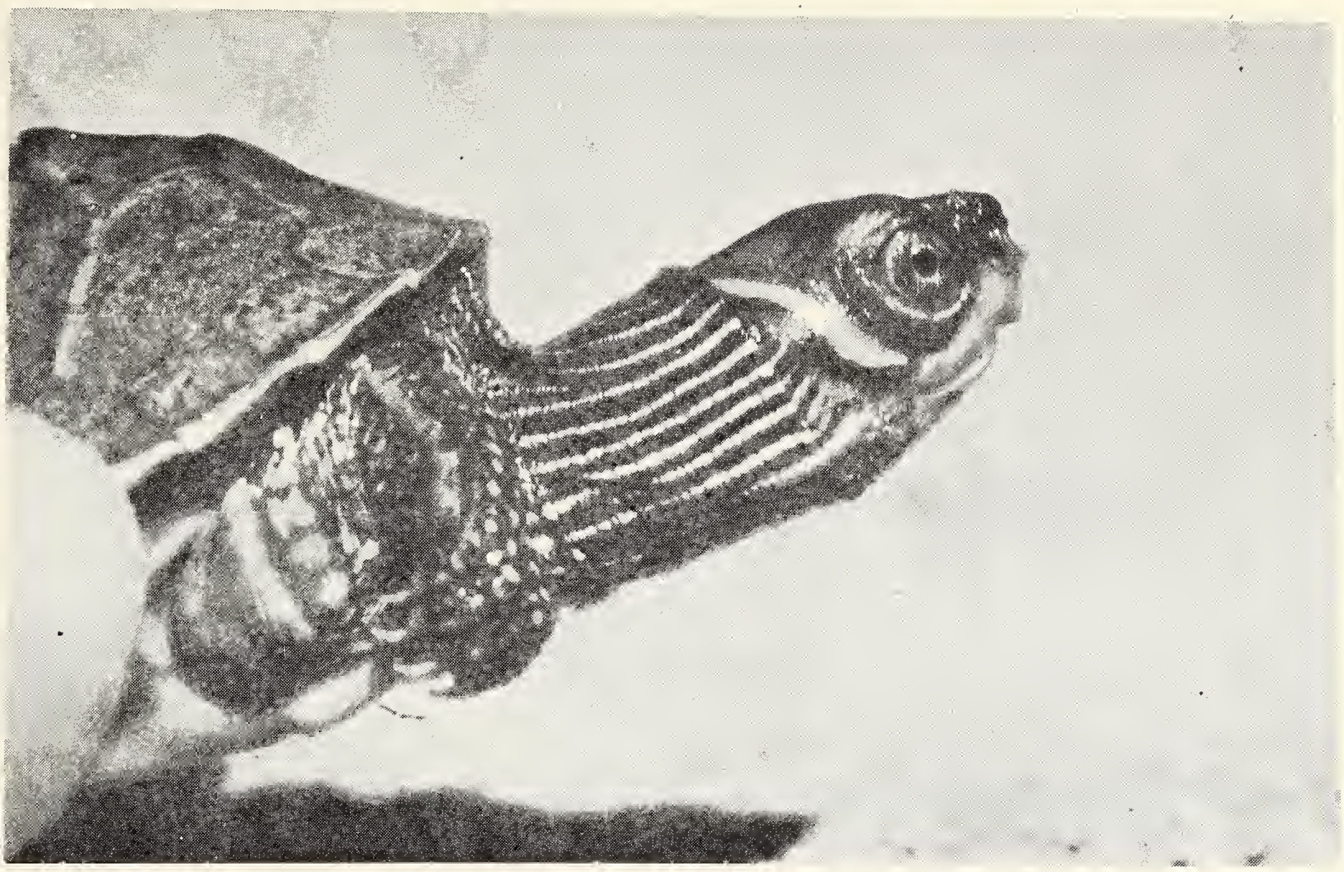
TABLE 1

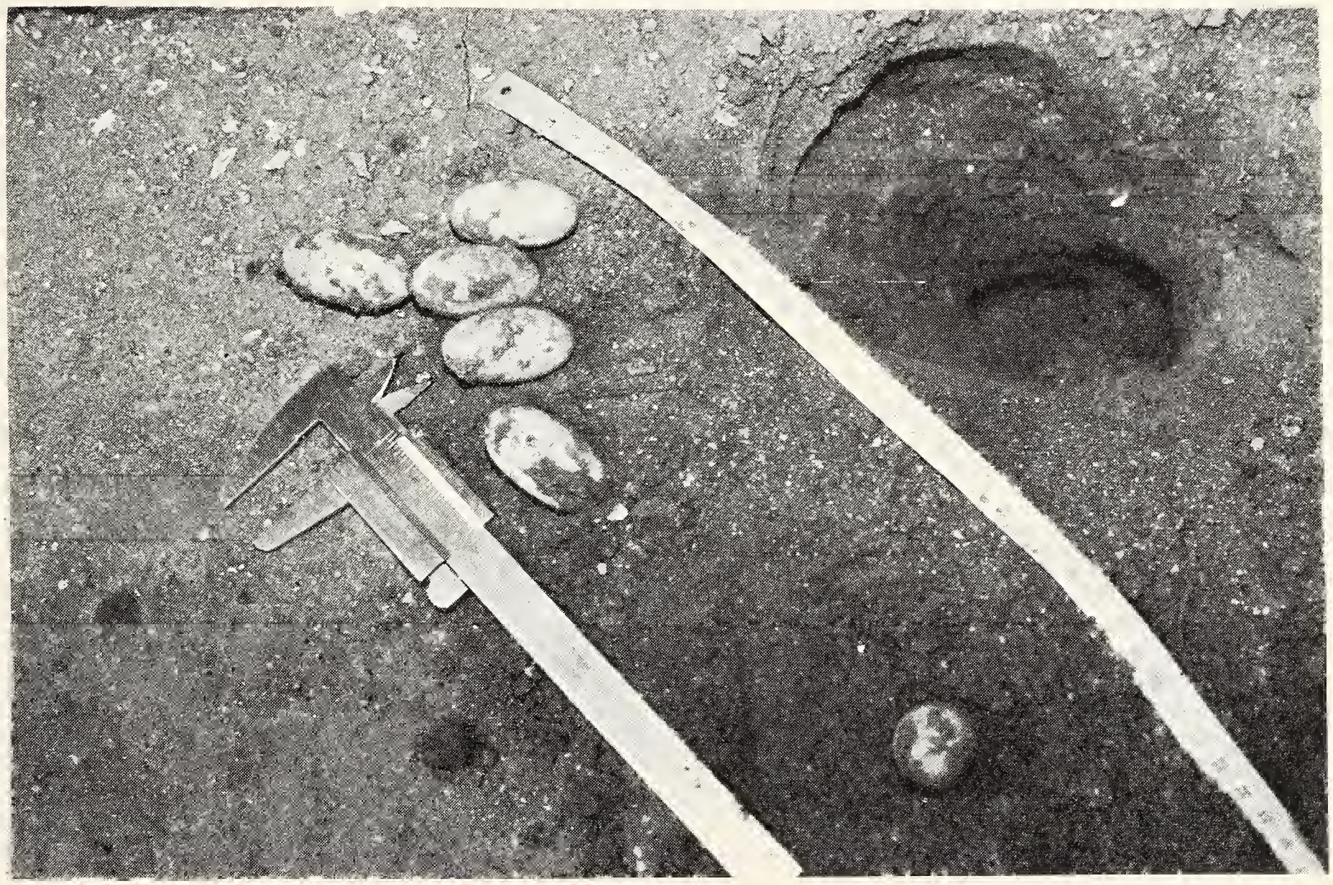
CLUTCH, EGG SIZE AND INCUBATION PERIOD OF *Kachuga tecta*

Nest No.	Clutch	Size of Eggs Length (Range)	Mean ± SD	Width (Range)	Mean ± SD	Date of lying	Date of hatching	No. of hatchlings	Incubation period (days)	Success of hatching
1.	7	4.18-4.50	4.34 ± 0.12	2.30-2.37	2.34 ± 0.02	20 Feb '91	15 May '91	7	70	100%
2.	9	4.18-4.47	4.34 ± 0.08	2.23-2.34	2.28 ± 0.03	3 Mar '91	21 May '91	4	78	44.4%
3.	10	4.05-4.46*	4.20 ± 0.14	2.28-2.40	2.34 ± 0.04	5 Mar '91	—	nil	—	00.0%
4.	5	4.23-4.34	4.30 ± 0.04	2.29-2.34	2.31 ± 0.02	9 Mar '91	—	nil	—	00.0%

All measurements in centimetres.

*Average of the 6 + 4 broken eggs.





Above: Newly hatched *Kachuga tecta* with egg tooth.
Below: Nest chamber and eggs of *Kachuga tecta*.

temperature recorded for nests 1 and 2 ranged from 25.6° to 28.9° C (Table 2).

Hatching behaviour: The first of seven hatchlings in nest 1 emerged on 1 May 1991 at 0600 hrs and another six within 28 minutes. Hatching success was 100%.

From nest 2, four hatchlings came out (success 44.4%). The first hatchlings came out on 21 May 1991 at 0800 hrs and thereafter another three emerged within six minutes. On examination the remaining eggs were found to be unfertilised.

Nests 3 and 4 were examined after 100 days. All the ten eggs from nest 3 were infertile. In nest 4, three out of five were found to be fertile but the embryos were dead after initial development.

All the hatchlings were healthy, very active and bright in colour. In shape they were quite similar to their parents. The average sizes of the hatchlings are given in Table 3. All hatchlings were then transferred from the breeding pool to rearing pan for further care.

RESULTS AND DISCUSSION

Egg laying in *Kachuga tecta* was earlier observed in October (Mishra 1984), December (Vijaya 1982) and January (Moll 1987). Our observations on nesting and egg laying were made between afternoon and evening during the months of February and March. Our observations thus extend the breeding season up to March from January recorded by Moll (1987).

The smallest clutch size observed was of three eggs, and the largest of 10 eggs. Vijaya (1982) observed clutch sizes of 4-8, while Rashid (Sept. 1991, pers. comm.) reported the largest clutch of 14 from Bangladesh.

The incubation period recorded in the present study ranged between 70 and 78 days. Vijaya (1982) reported 125-144 days. The shorter incubation period in the present study may be due to the change in micro-climatic condition and habitat structure. The record of temperature shows only 3° to 4°C variation throughout the incubation period in the nest, though there was considerable variation in air temperature. It is believed that this temperature condition in the nest may have enhanced the rate of development. The failure in nests 3 and 4 may be due to sterile eggs; alternatively the handling of eggs might have killed the embryos. The most plausible reason suggested for the 100% failure in nest 3 is that the male must not

TABLE 2
TEMPERATURE RECORDS OF AIR (TEMP. NEAR NEST) AND NEST (MIDDLE OF NEST CHAMBER NEAR EGGS) OF *Kachuga tecta* (IN °C)

Nest No.		0900 hrs		1500 hrs		1800 hrs	
		Air	Nest	Air	Nest	Air	Nest
1*	Max.	28.0	28.0	35.0	32.0	35.0	32.0
	Min.	22.0	22.0	30.0	28.0	29.0	27.0
	Mean	26.0	25.0	31.0	27.0	30.0	28.5
2**	Max.	29.0	29.0	39.0	33.0	36.0	32.0
	Min.	22.0	23.0	31.0	29.0	28.0	28.0
	Mean	26.6	25.6	32.5	27.0	31.6	29.7

* Average of 70 days, ** Average of 78 days.

TABLE 3
AVERAGE SIZE OF HATCHLINGS OF *Kachuga tecta* (IN CM)

Nest no.	Carapace length		Carapace width		Plastron size		Body height	Weight (g)
	Tape meas.	Vernier	Tape meas.	Vernier	Length	Width		
1*	4.10	3.52	4.21	3.08	3.06	2.64	2.33	9.14
2**	3.92	3.41	4.00	2.85	2.97	2.52	1.87	7.50

* Average of 7, ** Average of 4 hatchlings.

have fertilised the female after courtship. Further observations are required for confirmation.

ACKNOWLEDGEMENTS

We are grateful to Shri V.A. Jadeja, Curator of the Sayaji Baug Zoo, Baroda, for encouragement and facilities provided.

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20. STARRED TORTOISE *GEOCHELONE ELEGANS* (SCHOEPFF) IN CHINNAR WILDLIFE SANCTUARY, KERALA

Among the land tortoises, the starred tortoise *Geochelone elegans* (Schoepff) is reported to be common in semi-arid and desert tracts of south India (BOOK OF INDIAN REPTILES, Daniel, J.C. 1983). It is further stated that precise information about the status of this tortoise in this range is lacking. Similarly, Das (COLOUR GUIDE TO THE TURTLES AND TORTOISES OF THE INDIAN SUBCONTINENT, 1991) mentioned its distribution in Kerala as "south east Kerala". Apart from this, there is no information available on the geographical distribution of this species in the state.

In a survey conducted in July 1988, this tortoise was recorded from Churilippatty area of Chinnar Wildlife Sanctuary, Kerala (10°15′ to 10°22′ N, 77°05′ to 77°17′ E). This is the first record of this species from this locality and one of the few specific records for Kerala. A single animal was sighted during the survey at an altitude of 500 m.

Chinnar Wildlife Sanctuary is different from other wildlife sanctuaries of Kerala in its vegetation. This is the only protected area in Kerala with semi-arid and dry deciduous scrub forests, the preferred habitat of the starred tortoise.

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21. OCCURRENCE OF TWIN-SPOTTED WOLF SNAKE *LYCODON JARA* (SHAW) (DIPSADIDAE : LYCODONTINAE) IN RAJAJI NATIONAL PARK AND DOON VALLEY, UTTAR PRADESH

The twin-spotted wolf snake *Lycodon jara* was described by Shaw (1802) as *Coluber jara* from Ganjam (Orissa). Subsequent to this discovery, the snake was recorded from the neighbourhood of Darjeeling (Wall 1909a), Upper Assam (Wall 1909b), Bengal, Eastern Himalaya, Assam, Burma - Manipur, Pegu (Wall 1923). Gunther (1864) reported it from 'Annamallay' mountains. Wall (1923) in a footnote states "Specimens in the British Museum of Colonel Beddome's collections are labelled 'Malabar' and 'Anamallays'. These localities are to be discredited for reasons cited in the note below *Natrix parallelus.* Pegu on the authority of Stoliczka calls confirmation".

Smith (1943) gave the distributional range as Ganjam in the northern part of the Madras Presidency; the Eastern Himalayas as far west as longitude 85° E; Bengal; Assam. Waltner (1975) mentioned its distribution in E. Himalayas (Sikkim and Darjeeling) as far west as longitude 85°; Bengal, Khasi Hills, Assam and Ganjam in the northern part of Madras state and the altitudinal record from plains to 6,000 feet (1829 m). After a gap of 34 years Talukdar and Dasgupta (1977) recorded a lone specimen of *Lycodon jara* from Katernia Ghat, district Bahraich (Uttar Pradesh) collected by Romulus Whitaker, being the first record from Uttar Pradesh and its terai region. Murthy (1984) broadly mentioned the distribution as Uttar Pradesh; Ganjam, Orissa; Eastern Himalayas, Assam.

While studying the snake collections present in the Northern Regional Station, Zoological Survey of India, Dehra Dun, we came across two brilliantly coloured specimens of *Lycodon jara* collected from two different localities, Rajaji National Park and Doon Valley. The present communication records of occurrence of the dipsadid snake, *Lycodon jara* (Shaw), commonly known as the twin-spotted wolf snake, in the Siwalik Hills of the Rajaji National Park and Doon Valley, District Dehradun, Uttar Pradesh. Some salient observations on its colouration in life and ecology are also discussed. Interestingly the present finding adds a new distributional record, the foot hills of the western Himalaya.

Material examined: One example, female, 370 mm total length (tail length 80 mm). Loc. Asarori Forest nr. Police checkpost, Rajaji National Park, District Dehra Dun (U.P.); 20 August 1985; Collector P. Roy.

Lepidosis: Dorsals 17:17:15, ventrals 178, anals 1 (divided), subcaudals 71 (paired), supralabials 8, temporals 2 + 3.

One example, male, 190 mm total length (tail length 38 mm). Loc. Northern Regional Station, ZSI compound, 218 Kaulagarh road, Dehra Dun (U.P); 11 November 1990; Collector P. Roy.

Lepidosis: Dorsals 17:17:15, ventrals 176, anals 1 (partially divided), subcaudals 66 (paired), supralabials 8, temporals 2 + 3.

Colouration: Well-marked and distinguished readily from other species. Olive-green above with golden yellow twin spots on each scale with an iridescent shine. On preservation, the general colour becomes brownish or purplish-black and the spots whitish. The edge of upper jaw and lower surface of body are uniformly white. The specimens are devoid of the yellow/white collar. The eyes are black. The twin spots are club-shaped, pointing inward and backward, making an angle with each other. The overall arrangement of these spots on the dorsal surface of the body gives the impression of rosette pattern.

Habitat: The specimen from Rajaji National Park was collected from under a stone on the bed of a seasonal river. The river bed was covered with stones, gravel and leaf litter. The humus-rich leaf litter was rich in earthworms, insects and their larvae, micro-arthropods and the juveniles of a burrowing frog *Tomopterna breviceps.* The specimen from Doon Valley was collected from under a pile of stones adjoining a manure heap used for gardening.

Behaviour: It is nocturnal in habit but very active in its movements. When disturbed, it tries to escape by pushing its depressed head into the gravel or debris around boulders or stones. When disturbed repeatedly it tries to strike and sometimes makes its body stiff as if dead.

We are grateful to the Director, ZSI, Calcutta, and the Officer-in-Charge, Northern Regional Station, ZSI, Dehra Dun for encouragement and facilities.

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22. *AMPHIESMA MONTICOLA* (JERDON) AT BHADRA WILDLIFE SANCTUARY, KARNATAKA

Muthodi (13°27′ N, 75°38′ E; 760 m above msl), is about 32 km from Chickmagalur and part of the Muthodi range of the Bhadra Wildlife Sanctuary in the Western Ghats of Karnataka.

On 7 October 1991 a snake was caught from amongst short grass on the lawn in front of the Forest Range Office as it was moving towards an adjoining patch of overgrown lawn. The habitat is tropical moist deciduous forest and the nearest shola is less than two kilometres away.

The snake had 19 rows of scales at midbody, the outermost row not being keeled. Ventrals numbered 138 and caudals 91. Supralabials 8, white in colour, with 3,4 and 5 touching the eye. A spot above each eye on the black head and a white line on the top of the head extending behind the eye (to the postoculars). The yellow neck contrasted with the black head. The body was green with black transverse bands broken into three spots by two longitudinal lines. The specimen measured 309 mm total length while the tail measured 89 mm. Comparing the above characters with Smith's description (FAUNA OF BRITISH INDIA, 1943) the snake was as identified *Amphiesma (Natrix) monticola* (Jerdon). The snake was released after being photographed.

As the species is considered to be comparatively rare (Smith 1943) the present sighting is of importance, though it has been recorded well within its known distribution limits. Wall (*JBNHS 26:* 552-584, 1919), writing on snakes of Nilgiri hills and Wynaad, considers this species uncommon though he obtained 13 specimens in four months.

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23. OCCURRENCE OF CANTOR'S BLACKHEADED SNAKE *SIBYNOPHIS SAGITTARIUS* IN SRIHARIKOTA, ANDHRA PRADESH

On 13 August 1991, while carrying out ecological studies at Sriharikota island (13.45° N, 80.20° E) in south coastal Andhra Pradesh, one of us (PR) received a dead snake from one of our local assistants. The snake had apparently been killed by some of the villagers in the Keepakam area of Sriharikota island.

The specimen measured 230 mm from head to tip of tail (body 150 mm, tail 80 mm) and seemed to be a juvenile. It was immediately preserved in 4% formalin and subsequently taken to BNHS and identified as Cantor's blackheaded snake *Sibynophis sagittarius*. The morphological characters are as follows: body cylindrical; tail pointed; scales smooth, in 17 rows; ventrals 167, rounded; subcaudal 77, paired; loreal small; eight supralabials, 3rd, 4th, and 5th touching the eye; single temporal; parietal touches both postoculars. The colour of the snake matched well with the description by Smith (1943).

The present distributional range of *S. sagittarius* extends from north-east India to parts of central and western India. Recently, the related species, Dumeril's blackheaded snake *Sibynophis subpunctatus*, was reported for the first time from Pt. Calimere Sanctuary in Tamil Nadu by Natarajan and Alagar Rajan (1991) and also from Srivilliputtur Reserve Forest, Tamil Nadu by Malhotra and Davis (1991). From the collection records of BNHS it is known that *S. sagittarius* has been collected from Orissa and Tamil Nadu. However, there is no information available on its occurrence in Andhra Pradesh; this is the first record.

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24. *APLOCHEILUS PANCHAX* (HAM.) — AN ADDITION TO THE FISH FAUNA OF RAJASTHAN

Kumar and Asthana (in press) recently compiled and reviewed the fish fauna of Rajasthan. The total number of species recorded from the state was 115. A fish survey was carried out during the summer months of 1989, to study the species composition, abundance and distribution of fish fauna along the course of the Banganga and Gambhir river systems. They have a large catchment area starting from Manoharpur (near Jaipur) in the west, Karauli in the south and up to Yamuna (near Agra) in the east. Keoladeo National Park, the renowned wetland at Bharatpur, also receives water from these rivers.

During the survey a total of 46 species of fish were recorded, of which *Aplocheilus panchax* was recorded for the first time from Rajasthan. According to Jayaram (1981) it has a wide distribution in peninsular India. This species was frequently observed in and around Ramgarh (near Jaipur). Other species of the same genus recorded from Rajasthan are *A. lineatus* (Valenciennes) from Udaipur (Datta Gupta *et al.* 1961) and Jodhpur (Datta and Majumdar 1970) and *A. blochii* (Arnold) from Jodhpur (Mathur and Yazdani 1969). With the addition of *A. panchax*, the total number of fish species recorded from Rajasthan has now increased to 116.

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25. NORTHWARD MIGRATION OF THE COMMON INDIAN CROW BUTTERFLY *EUPLOEA CORE* (CRAMER) IN AND AROUND BOMBAY

Migration of *Euploea core* around Bombay city was first observed by Prall (1898) and Aitken (1898, 1900). Other observations on migration of this species are those by Evershed (1910), Williams (1938, northward migration) and Chaturvedi (1979, southward migration in the Western Ghats). For the last 55 years there are no specific records on migration of *Euploea core* in and around Bombay city.

On 11 July 1992 I saw an *Euploea core* migration flight in a north-western direction at Prince of Wales Museum. In half an hour's time I counted 85 butterflies. I continued random observations in various parts of Bombay (Table 1).

I did not come across any specific migration between 16 and 30 July though *Euploea core* was common in the Sanjay Gandhi National Park, Borivli, during that period. Northward migration was also observed along the eastern express highway by Dr Meena Haribal.

As per my observation *Euploea core* prefers to fly along an open alley or track such as a road or railway tracks in a slow but steady flight in a north-western direction.

Usually they fly at about 2 m above the ground, but occasionally as low as 50 cm. When obstacles (buildings etc.) lie in their migratory path they fly around the obstacle rather than over it, and after finding a gap or open space they revert to their original course. The average speed of flight, measured over a 5 m long stretch of the migration path, was 9 km/hour.

This would support Aitken's (1900) hypothesis that butterflies migrate to avoid heavy rains rather than in search of new breeding grounds. Some of the food plants of the common Indian crow butterfly

TABLE 1
MIGRATION OF *Euploea core* AT BOMBAY

Date	Place	No. of butterflies counted	Time	Direction
11 July '92	Nr. Prince of Wales Museum	85	1030 to 1100 hrs	North-west
12 July '92	Goregaon (Along the railway track)	36	0850 to 0914 hrs	North-west
13 July '92	Goregaon	48	0850 to 0910 hrs	North-west
14 July '92	Flora Fountain	12	1000 to 1010 hrs	North-west
	Also *D. genutia,*	2		
	Tirumala limniace	2	0845 to 0905 hrs	North-west
15 July '92	Matunga	17		
31 July '92	Goregaon, S.V. Road	22	1230 to 1330 hrs	North-west
1 Aug. '92	Goregaon East	60	1035 to 1100 hrs	North-west

(*Streblus asper, Ficus bengalensis, Ficus racemosa, F. religiosa, Holarrhena, Nerium odorum, N. oleander, Hemidesmus indicus* and *Cryptolepis elegans*) are plentiful in and around Bombay city.

I am thankful to my friend Mr B.R. Pai, who helped me to measure and record observations.

September 21, 1992 NARESH CHATURVEDI

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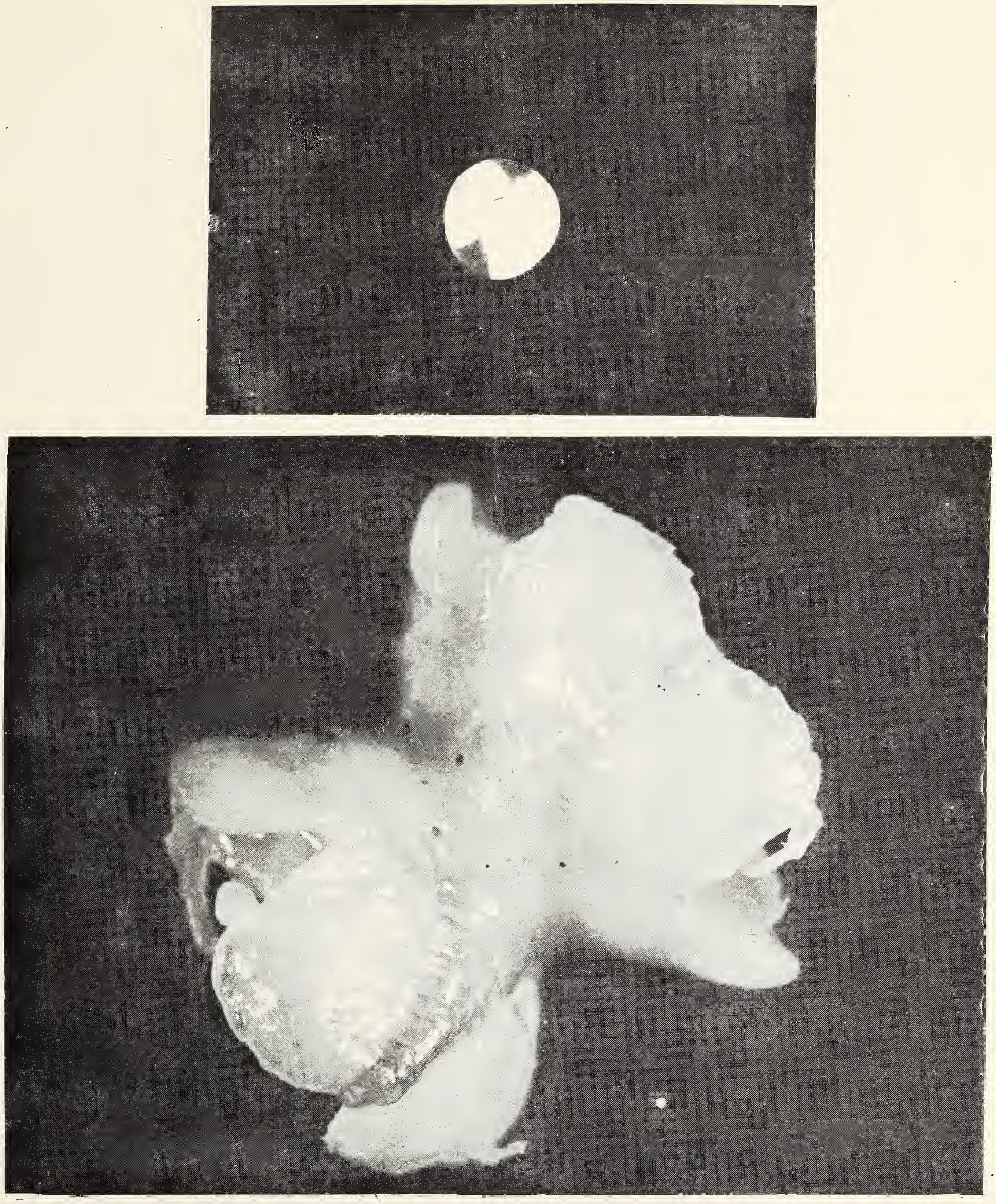
26. A FREAK TWIN TRILOBITE LARVA OF THE INDIAN HORSESHOE CRAB *TACHYPLEUS GIGAS* (MULLER)

(With a plate)

The horseshoe crab *Tachypleus gigas* (Muller) is found abundantly along the north-east coast of India (21°17′ N, 87°00′ E). In India, so far, no attempt has been made to study the developmental stages of this species. Earlier, 21 embryonic stages in the Japanese species *Tachypleus triodentatus* (Seikiguchi 1973), nine stages in *Limulus* (Scholl 1977) and 20 stages in *Limulus polyphemus* (Brown and Clapper 1981) have been reported.

Gametes from a mature pair of *T. gigas* were collected by applying electric current of 6 V (400 mA DC) on gonopore of the male and female, and fertilisation was performed *in vitro*. Fertilised eggs were kept at a constant temperature of 27°C ± 1°C in recirculating seawater incubators. Early embryonic stages were studied by using micrographs of live embryo. A total of 130 eggs were fertilised in the present study. A freak egg showing two trilobite larvae bridged with each other was noticed on the 38th day after fertilisation (Plate 1). The posterior margins of the opisthosoma of the trilobite larva were found attached to each other and margins of the prosoma showed hair-like sensory filaments. The body of the larvae was flattened with large cephalothorax and abdomen. Size (4.5 mm in length; 3.6 mm in width) and shape of the trilobite larvae showed all the characters of an adult horseshoe crab. Movement of the larvae inside the extra embryonic shell was rather slow. 39 days after



Above: Twin trilobite larvae inside the extra embryonic shell, ready to hatch.
Below: Free swimming twin trilobite larvae (size 4.5 mm length, 3.6 mm width).

fertilisation, the larvae hatched out and started swimming freely (Plate 1). However, on the 56th day after fertilisation the twin trilobite larva was found dead.

We are thankful to Dr B.N. Desai, Director, NIO, for facilities. One of the authors (JKM) is grateful to the Department of Ocean Development for award of a Research Fellowship.

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27. RECORD OF *ATELOPSALIS PACIFICA* BARTSCH 1985 (HALACARIDAE : ACARI) FROM EASTERN INDIAN OCEAN

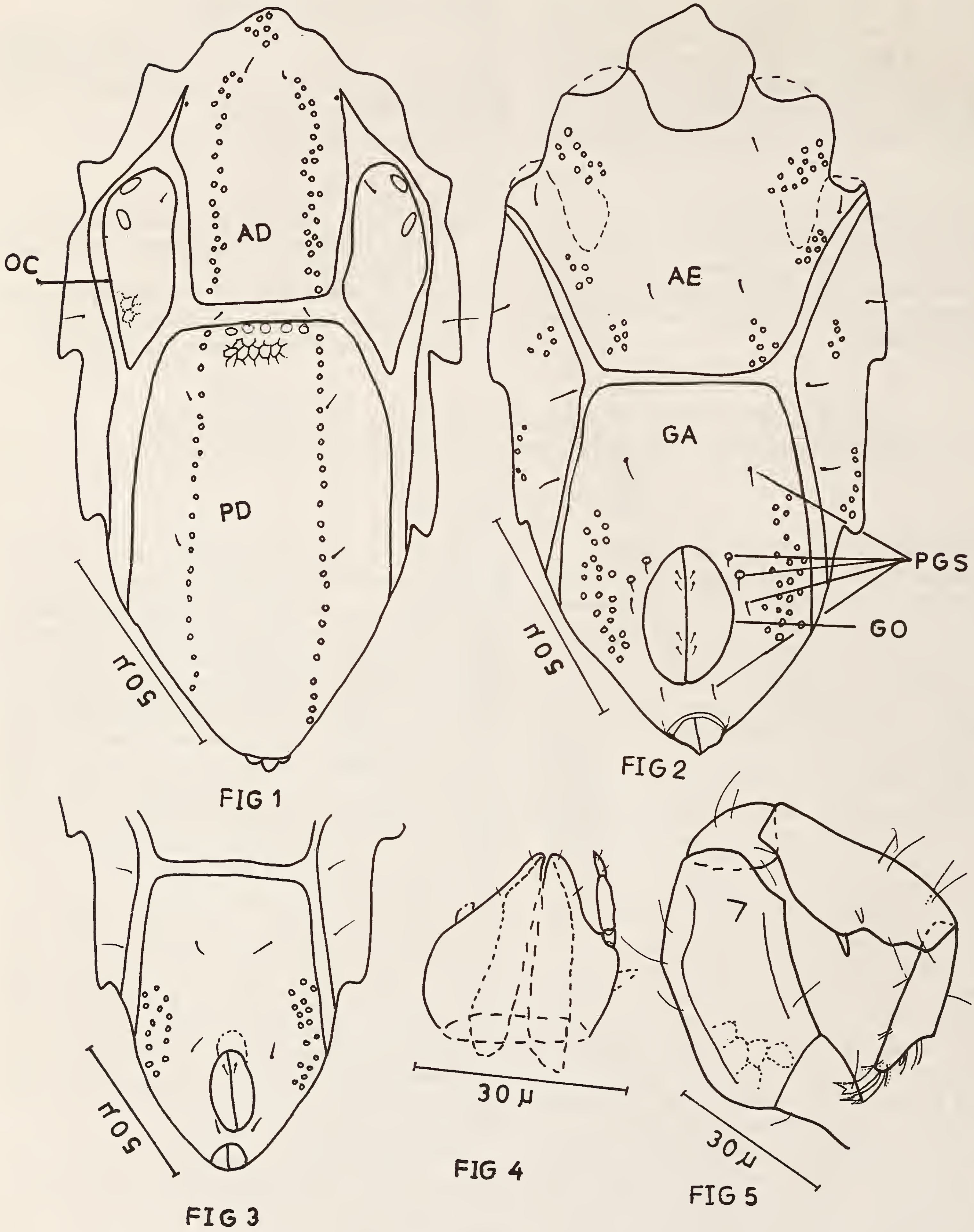
(With five text-figures)

In the course of taxonomic studies on halacarids of the Indian coast, 10 specimens of *Atelopsalis pacifica* Bartsch 1985 (Halacarinae : Halacaridae) were obtained from the thalli of coralline alga *Jania rubens* collected from Chatham island, Port Blair (Bay of Bengal). *A. pacifica* is known so far only from its type locality, Mactam islands, Philippines in the Pacific Ocean (Bartsch 1985). The genus *Atelopsalis,* comprising of five named and one undetermined species, is known from the north-east Atlantic ocean (Trouessart 1896, Bartsch 1973), Galapagos (Bartsch 1977), Mozambique channel (Bartsch 1982), and Mactam island, Philippines (Bartsch 1985) so far. Habitat depth and geographic distribution of all the species of the genus are shown in Table 1. Both the genus and species are recorded for the first time from Indian seas and eastern Indian Ocean.

The specimens agree with the original description (Bartsch 1985) of *A. pacifica*. However, a brief description is given below for ready reference. The idiosomal measurements of males ranged from 171 µm to 187 µm and females from 187 µm to 204 µm. Anterodorsal plate (AD) bears three areolae (one anterior and two posterior). Posterior two areolae long, one/two pore wide, parallel posteriorly and tending to converge anteriorly; dorsal seta 1 (ds_1) on AD located anterior to the posterior areolae and dorsal seta 2 (ds_2) on the anterior region of ocular plate (OC) (Fig. 1). OC with two corneae and panelled posteriorly but devoid of areolae. OC caudiform posteriorly, extending beyond the insertion of leg 3. Dorsal setae 3 (ds_3) on the cuticular membranous area between AD and PD (posterodorsal plate). PD with two costae and one pore wide. All ventral plates separate (Fig. 2). Anterior epimeral plate (AE) bears three pairs of areolae, one pair posterolaterally, one pair on 1st coxal prominences and a pair of small areolae comprising a few pores below the 2nd coxal prominences. In males the genitoanal plate (GA) bears five pairs of perigenital setae (PGS) — one pair distinctly anterior to genital opening (GO), one pair just posterior to GO and three pairs distributed on either side of the GO — and in addition, four pairs of subgenital setae (SGS) on sclerites (Fig. 2). Gnathosoma and palp are very small. Palp 3-segmented. Palpal segment 1 (P_1) is very short, 2nd segment (P_2) the longest and the 3rd segment (P_3) intermediate. P_2 is without any setae and P_3 with one basal and one distal seta (Fig. 4). Telofemur 1 with denticulous projection anteromedially. Tibia 1 with eight setae (of which two are thick, stout and small) and patella 1 with four setae (Fig. 5).

In females, GA bears three pairs of perigenital setae and a pair of subgenital setae. Ovipositor is small (Fig. 3). All other characters are similar in males and females.

Table 1 shows that the genus *Atelopsalis* is probably conservative in speciation and the species


OC
AD
PD
50µ
FIG 1
AE
GA
PGS
GO
50µ
FIG 2
50µ
FIG 3
30 µ
FIG 4
7
30 µ
FIG 5

Figs. 1-5. *Atelopsalis pacifica* Bartsch
1. Idiosoma dorsal (male); 2. Idiosoma ventral (male); 3. Genito-anal plate (female); 4. Gnathosoma; 5. Leg I.

TABLE 1
WORLD DISTRIBUTION OF *Atelopsalis*

Species	Author	Habitat/Depth	Locality
A. tricuspis Trouessart	Trouessart 1896	1410 m	Gulf of Gascogne
	Bartsch 1973	291-256 m	Josephine Bank, north-east Atlantic ocean.
A. newelli Bartsch	Bartsch 1973	193-291 m	Josephine Bank, north-east Atlantic ocean.
A. aliger Bartsch	Bartsch 1977	Intertidal interstitial	Galapagos, eastern Pacific ocean.
A. ridens Bartsch	Bartsch 1982	335-390 m	Mozambique Channel, western Indian ocean.
Atelopsalis sp.	Bartsch 1982	750 m	Mozambique Channel, western Indian ocean.
A. pacifica Bartsch	Bartsch 1985	15 m depth, shallow subtidal	Mactan island, Philippines (Pacific ocean).
	Present report	Intertidal, associated with coralline algae *Jania rubens*	Chatham island, Port Blair, Andaman islands (Bay of Bengal).

are apparently endemic in distribution, since all the species except the one under report are known only from their type localities. However, the type species of the genus *A. tricuspis* Trouessart is known from Josephine Bank (Bartsch 1973) and Guscogne (Trouessart 1896) (the type locality) but both localities are in the region of north-east Atlantic Ocean. The present studies extend the distribution of *A. pacifica* into the Indo-Pacific region for the first time.

Regarding the bathymetric distribution, *A. aliger* and *A. pacifica* are known from the intertidal and shallow subtidal waters respectively, while the rest are from depths ranging between 193 m and 1410 m.

ACKNOWLEDGEMENTS

Thanks are due to Dr. Ilse Bartsch, Biologische Anstalt Helgoland, Hamburg, for her ready help in providing literature and expert comments. Thanks are due to the authorities of Regional College of Education, Bhubaneswar, for extending laboratory facilities.

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28. ON AN INTERESTING COLLECTION OF *BAUHINIA* (LEGUMINOSAE : CAESALPINIOIDEAE) FROM ARUNACHAL PRADESH

(With two text-figures)

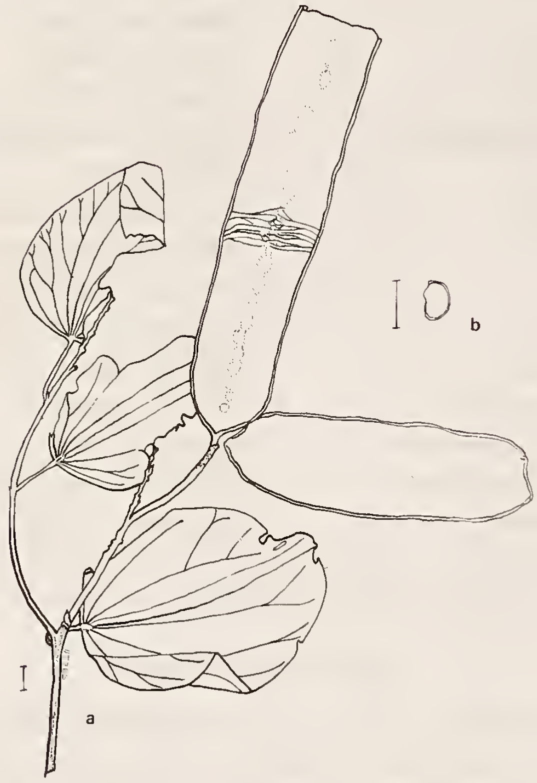

Fig. 1. *Bauhinia tenuiflora* Watt ex Clarke.
a. Fruiting twig; b. Seed. Scale = 1 cm.

In the course of a taxonomic study on the Indian *Bauhinias* we came across an interesting herbarium specimen (*J. Joseph* 48504 - CAL) collected from forest around Tihun in Lohit district of Arunachal Pradesh. The fruiting material though identified as '*Bauhinia tenuiflora* Watt ex Clarke sharply differs from the said taxon and resembles very closely *Bauhinia ovatifolia* T. Chen (in Guihaia 8(1): 50.1988), a species known only on the basis of flowering specimens from the type locality (Tianyang, Guangxi) in South China.

The morphological description of the specimen (collected on 8 December 1969) together with its illustrations (Fig. 1) and scanning photomicrograph of the ultramicroscopic pattern on the seed surface are given here (Fig. 2) to facilitate identification in the field. The identity of specimens can be determined by studying the fruits of *B. ovatifolia* T. Chen from the type locality and the flowers from the plants bearing this kind of fruit in north-east India.

Robust tendrilled climber. Leaves 8.5-11 x 5.7-9.5 cm, ovate, entire, 9-nerved, subacuminate to obtuse at apex, subtruncate to obtuse at base, glabrous above, ferruginous pubescent below; petioles 1.7-3 cm long, glabrous. Fruits (broken at apex) up to 19 x 4 cm, pinkish brown, oblong, flattened, thin valved, veined, glabrous, up to 20-seeded, indehiscent. Seeds *c.* 0.9 x 0.7 cm, blackish brown, ovate-orbicular, smooth but ultramicroscopically rugulate (only the central portion of the seed surface has been observed under a 'PSEM 500' after gold coating the sample in an 'Edward sputter-coater'), compressed, with scar mark of funicular aril-lobes running around two-thirds of its circumference; hilum yellow.

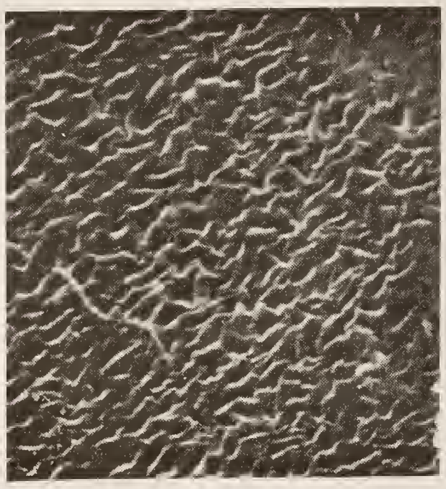

Fig. 2. Scanning photo-micrograph of *Bauhinia tenuiflora* (x 800).

Acknowledgements

We are grateful to Prof. Kai Larsen of Aarhus University, Denmark, for his comments on the identity of the specimen. We are also grateful to Prof. Te-chao Chen of South China Institute of Botany, Academia Sinica for presenting the protologue of *B. ovatifolia* T. Chen and to the Scientist-in-Charge, R.S.I.C., for the use of Scanning Electron Microscope.

June 12, 1992

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29. *MERREMIA CISSOIDES* (CONVOLVULACEAE) — A NEW RECORD FOR INDIA

(With a text-figure)

The genus *Merremia* Dennst. ex Hall. f. with about 80 species is widely distributed in the tropics of both hemispheres (Austin, D.F. in REVISED HANDBOOK OF THE FLORA OF CEYLON, 1980, Dassanayake and Fosberg, eds.). During explorations in south India, we came across an interesting material of *Merremia* growing along the roadside at Pattom, Thiruvananthapuram. It was identified (subsequently confirmed by Dr Bernard Verdcourt, Kew) as *M. cissoides* (Lam.) Hall. f. As this species is not described in any of the Indian floras its nomenclature, description, illustration and other relevant notes are provided here.

Merremia cissoides (Lam.) Hall. f., Bot. Jahrb. Syst. 16: 552. 1898; Van Ootsroom, Fl. Surinan 84. 1932; O'Donnel, Lilloa 6: 520. 1941.

Type: French Guiana, Cayenna (P).

Convolvulus cissoides Lam., Tabl. Encl. 1: 462. 1791.

Ipomoea cissoides (Lam.) Griseb, Fl. Br. W. Ind. Isl. 473. 1861; Trimen, Handb. Fl. Ceylon 3: 212. 1895; Alston, in Trimen, Handb. Fl. Ceylon 6: 202. 1931.

Large herbaceous twiner; stem green, latex milky white, glandular hairs intermingled with white trichomes, bulbous based ± 4 mm long. Leaves palmately compound, leaflets five, sessile to subsessile, ovate to ovate-elliptic, basally acute to acuminate, apically long, acuminate to mucronate, terminal one larger, 3-5.5 x 1-1.5 cm, inner pair 2.5-3 x 1-1.5 mm, outermost pair 1.8-2.5 x 1-1.2 cm, margin dentate, puberulous; petiole up to 4.5 cm long, hirsute like stem. Flowers axillary, solitary or in 2-4 flowered cymes, peduncle as long as the petiole, glandular, hairy; bracteate, linear, 12-15 x 2-3 mm long, glandular pubescent with white trichomes, marginal hairs ± 4 mm long, pedicels short, ± 5 mm long, glandular pubescent; sepals broadly rhomboid to ovate, long acuminate apex, different in size, outermost two large, 20x5 mm, margin wavy, third single, medium sized, 17 x 4 mm, innermost pair small, 15x3 mm, with white trichomes and with glandular indumentum; corolla white, campanulate, tube 7-8 mm long, limb slightly 5-lobed, mouth 2-2.5 cm wide; stamens sub-exserted; anthers not contorted, tip curved after dehiscence, three mm long, filament often broadened at the base, subequal, three large, ± 7 mm long, two small, ± 5 mm long, white, hairy at base; pollen smooth. Ovary 4-celled; style subexserted, up to 8 mm long, stigma two, globular, white; disk small, 2 mm long, annular. Fruit capsular, compressed, 4-5 x 8 mm, light brown, the fruiting sepal slightly larger, white trichomes turns to yellowish white, seed subrotund, black, stellately appressed hairy, 4 x 3 mm. Seedling usually bicotyledonary, tricotyledonary seedlings are frequent, petiolate, ± 1 cm long, sinus deep, 2.5-4 mm, basally cordate, glandular hairy, margins wavy.

Distribution: Originally from the tropics of the New World, this species has been reported from Africa and Sri Lanka.

Flowering: December - March.

Material studied: *S.D. Biju* 40212 (Pattom, Thiruvananthapuram dt., Kerala) K, and CALI.

We thank Dr Bernard Verdcourt, Kew, for authentication of the identification.

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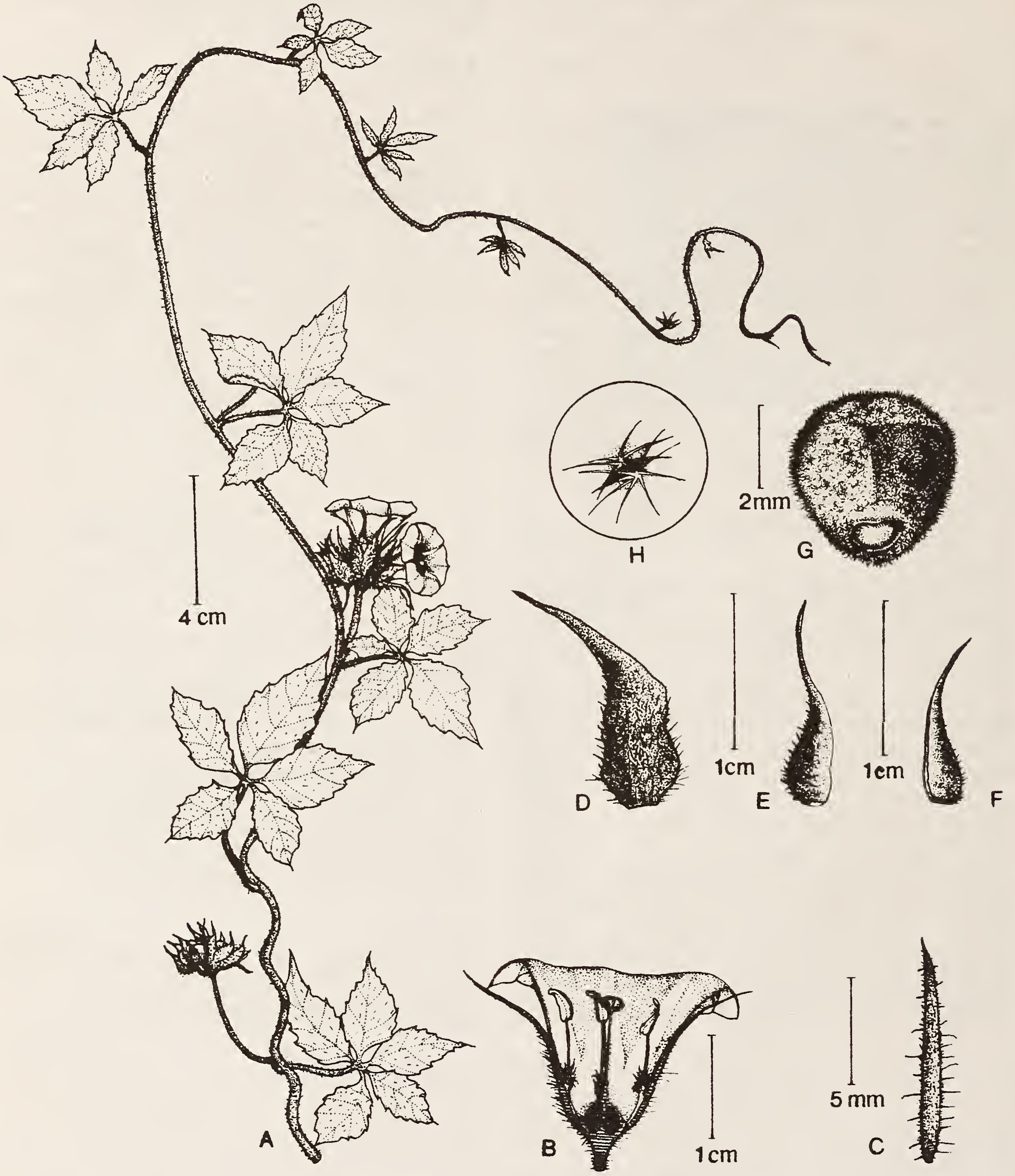
4 cm
A
H
2mm
G
D
1cm
E
1cm
F
B
1cm
5 mm
C

Fig. 1. *Merremia cissoides* (Lam.) Hall. f.
A. Habit; B. Flower L.S.; C. Bract; D, E, F. Calyx; G. Seed; H. Stellate hairs on seed.

30. ON BRANCHING IN *CARICA PAPAYA* L. (CARICACEAE)

Carica papaya L., considered to be a native of tropical Central America, is presently grown all over the tropical and sub-tropical countries of the world for its fruits and commercial papain. Being a sub-herbaceous, almost branchless tree, it is very rarely seen branching under natural conditions.

During my visit to Sattenapalle town in Guntur district, Andhra Pradesh, I happened to sight a branched papaya tree in a residential complex. On enquiry, the residents said that during a cyclonic storm the crown of the tree was decapitated. Subsequently, the severed stump first gave out two main branches of almost equal size at the apex, followed by four more branches of slightly smaller size just below the first two. Interestingly, all the branches bore leaves and fruits giving good yield. It is worth considering whether branching under natural conditions or owing to injury can be turned to our advantage since the tree is of considerable medicinal and economic value.

November 25, 1991 P.S.N. RAO

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31. *CHISOCHETON LONGISTIPITATUS* (F.M. BAILEY) L.S. SMITH (MELIACEAE) — A NEW RECORD FOR INDIAN FLORA

The Indo-Malayan genus *Chisocheton* Blume comprises 51 species. Hiern (in FLORA OF BRITISH INDIA, Hooker, J.D. 1875, pp. 550-553) reported nine species of this genus from India, in a wider sense the then British India. Mabberley (*Bull. Br. Mus. nat. Hist. Bot. 6 (4):* 301-386. 1979) recognised six species and two subspecies as occurring in India.

While studying the family Meliaceae in the Andaman and Nicobar islands, one of us (HSD) came across an unidentified specimen of *Chisocheton* Blume, collected from Great Nicobar Island, which on critical study was identified *C. longistipitatus* (F.M. Bailey) L.S. Smith, a species so far known to occur in Indonesia, Papua New Guinea, Solomon Islands and Australia.

This taxon can easily be distinguished from the other known Indian species of this genus by its long-stipitate fruits with spongy pericarp, channelled rachis ending in claw-like pseudogemmula and stellate pubescent nature.

Thus *Chisocheton longistipitatus* (F.M. Bailey) L.S. Smith forms a new record for the Indian flora. A brief description is provided.

Chisocheton longistipitatus (F.M. Bailey) L.S. Smith In Proc. R. Soc. Queensl. 70: 29.1959; Mabberley in Bull. Br. Mus. nat. Hist. (Bot.) 6 (4): 371.1979. *Castanospora longistipitata* F.M. Bailey, Queensl. Fl. 1: 288. 1899.

Tree, 15-20 m tall. Bark dark brown, lenticellate. Leaves 40-80 cm long; rachis 2.0-4.5 mm in diameter, channelled with short, claw-like pseudogemmula; leaflets 2-6 pairs, 5-25 x 4-10 cm, elliptic-oblong, sparsely stellate pubescent, midrib sunken, lateral nerves 14-18. Inflorescence 30-40 cm long, 3-6 branched; branches 2-8 cm long; calyx subsessile, 1-3 mm long; petals 4-5, 5.5-6.5 x 0.5-0.8 mm; staminal tube 5-lobed, pubescent in the middle; anthers five, *c.* 1 mm long, disk cupular; ovary 2-3 locular; style stellate pubescent below. Fruit spherical, 3-3.5 cm long, stipe 1-3 cm long, pericarp spongy. Seeds 2-3, discoid.

Specimens examined: INDIA: South Nicobars : Great Nicobar Island, near 40 km on East-West road, 26 September 1980, *D.K. Hore* 8220 (PBL).

ACKNOWLEDGEMENTS

We thank Shri M.K. Vasudeva Rao, Scientist-SD, Botanical Survey of India, Andaman-Nicobar Circle, for his kind help and encouragement.

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32. *ARGOSTEMMA COURTALLENSE* AND *A. ANUPAMA* (RUBIACEAE) REVISITED

(With two text-figures)

Argostemma courtallense is a fairly common species in the mountains of peninsular India. It was originally described by Walker-Arnott based on Wight's collection (*Wight*, Cat. n. 2474, K, photograph seen) from Courtallum. Wight himself made an illustration of this taxon in 1835, at Courtallum "Where only I have met with this plant" (Icon. p. 15, t. 1160. 1846). Subsequently, Sivarajan (1984) described a new species, *A. anupama*, based on a collection (*Sivarajan, D. 28706*, CAL & CALI) from wet rocks near Calicut University Campus in north Kerala.

Recently Deb and Basu (1990), after "examining not only the earlier collections, but also those collected since then and extant in different herbaria in India and abroad" have concluded that the Burmese species *A. tovoyanum* Wall. and the peninsular Indian *A. anupama* are conspecific with *A. courtallense*, and have reduced the names into synonyms of *A. courtallense.*

We have not been able to study *A. tavoyanum* and hence would not like to comment on its taxonomic status. But, with respect to *A. anupama* we cannot agree with the conclusion that "the subsequent gatherings... lead to modification or enlargement of the description (of *A. courtallense*) and the distinction does not hold good". This might, of course, reflect the difference in the concept of species, Deb and Basu taking the lumper's stance, and us the splitter's. But the question is how much of variability can be tied down to a single binomial. To resolve this issue satisfactorily, one has to go beyond earlier descriptions, as we have earlier pointed out (Sivarajan *et al.* in press). Such taxonomic revision and nomenclatural changes have to be preceded by adequate study of living specimens in living communities also, whenever possible, in addition to a careful study of dried herbarium specimens.

We have also examined the types, other authentic specimens and original descriptions of the two taxa and have found that the two differ in many more characters than have been delineated in the earlier description. Even as we might concede that "more than four petiolate leaves and smaller flowers are evident in some specimens" of *A. courtallense*, our findings do not corroborate the observation that in *A. anupama* "the anthers are free and curved, not connivent in a cone around style and stigma, as characterised by the author in the illustration – a characteristic evident in many species in young flowers, before anthesis". In *A. anupama*, the anthers are clearly connivent in a cone around the stigma, even in mature flowers, after anthesis. Besides, *A. courtallense* is characterised by ovate or ovate-elliptic leaves, symmetric at base, whereas *A. anupama* has ovate or lanceolate leaves which are highly oblique at base.

We are convinced that *A. courtallense* and *A. anupama* are distinct species. An artificial synoptic key and comparative illustrations of the species pair are provided below.

KEY TO TWO SPECIES OF *Argostemma*

1. Plants up to 13 cm tall; leaves mostly 4 in two decussate pairs, at times the internode is very short and they appear to be in a whorl of two unequal pairs, the lower pair petioled, upper pairs subsessile, laminar base regular; calyx much smaller than corolla, lobes ovate, with acute sinuses, corolla lobes broadly ovate, much larger than calyx lobes; staminal filaments free, bent at middle, anthers bright yellow, free, erect, and in a circle around stigma .... *A. courtallense*

— Plants up to 6 cm tall; leaves 3(-2) pairs, upper two pairs sometimes in a whorl, distinctly petioled, lamina prominently oblique at base; calyx larger than corolla, lobes broadly ovate with rounded sinuses; corolla lobes elliptic to lanceolate, as long as and narrower than the calyx lobes; staminal filaments free, twisted; anthers white, connivent in a cone around the style, erect at first, declinate later .... *A. anupama*

ACKNOWLEDGEMENTS

We thank Dr Diane M. Bridson, Kew, for literature and type photograph of *A. courtallense*. One of us (AKP) is grateful to CSIR, New Delhi, for awarding a fellowship.

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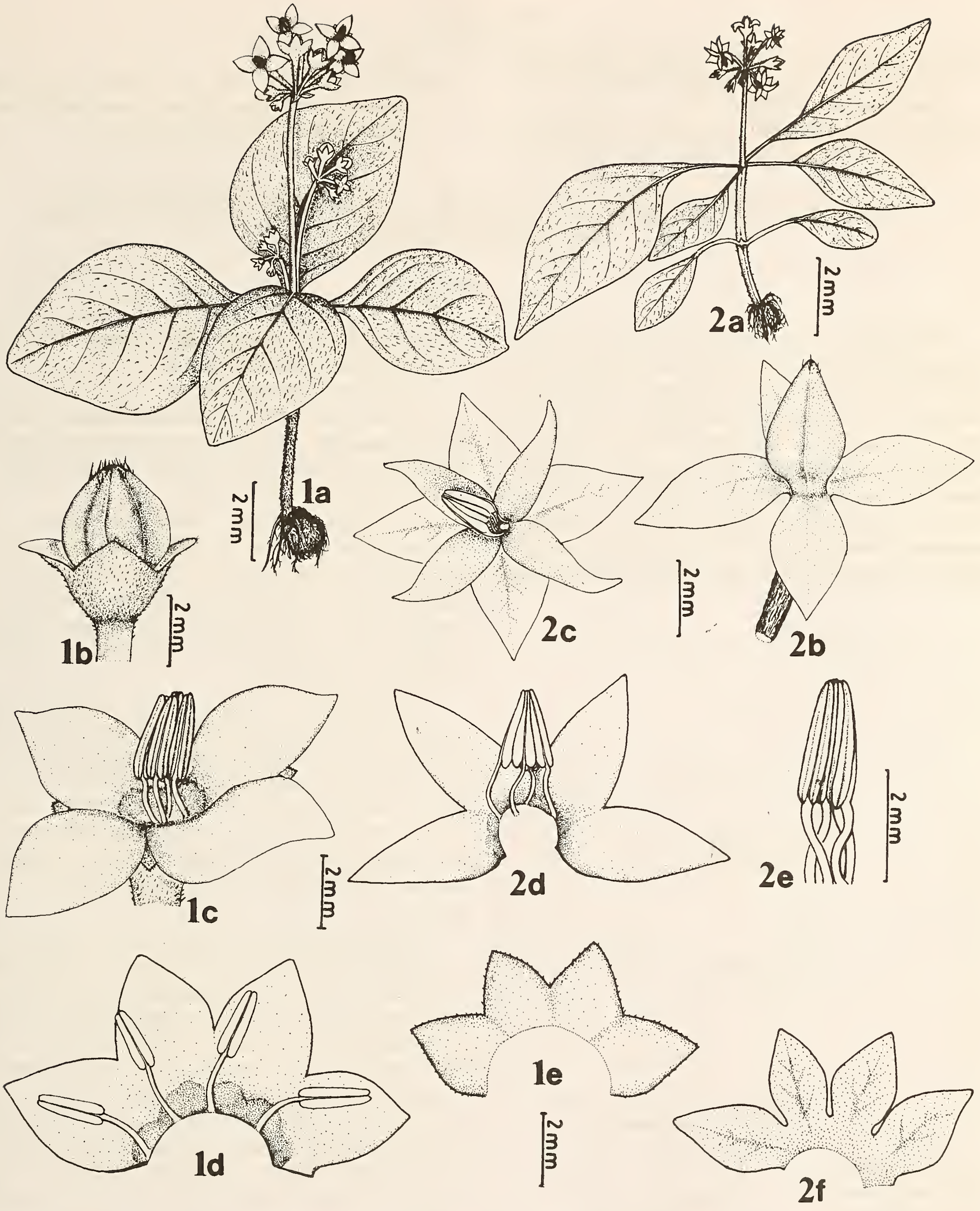
October 12, 1991


1a
2 mm
2a
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2b
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2 mm
2f

Fig. 1. *Argostemma courtallense* Arn. a. Habit; b. Flower bud; c. Open flower with stamens before anthesis; d. Corolla split open showing anthers separating after anthesis; e. Calyx showing acute sinuses.

Fig. 2. *A. anupama* Sivar. a. Habit; b. Flower bud; c. Open flower showing stamens before anthesis; d. Corolla split open; e. Stamens showing twisted filaments and connivent anthers; f. Calyx showing rounded sinuses.

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33. RANGE EXTENSION OF ENDEMIC *CEROPEGIA HUBERI* ANSARI IN MAHARASHTRA

(With a text-figure)

During the course of a botanical excursion in Varandha Ghat area of Pune district, Maharashtra, an unusual clump of plants belonging to the genus *Ceropegia* L. was noticed growing in vertical rock crevices in association with grass clumps. On critical examination, the species was identified and confirmed as *Ceropegia huberi* Ansari. It was also recorded at Susale island during subsequent botanical excursions in Mulshi area of Pune district. This report suggests an extension of the range of the species from Konkan northwards in Pune district in Varandha Ghat and Susale island (Fig. 1).

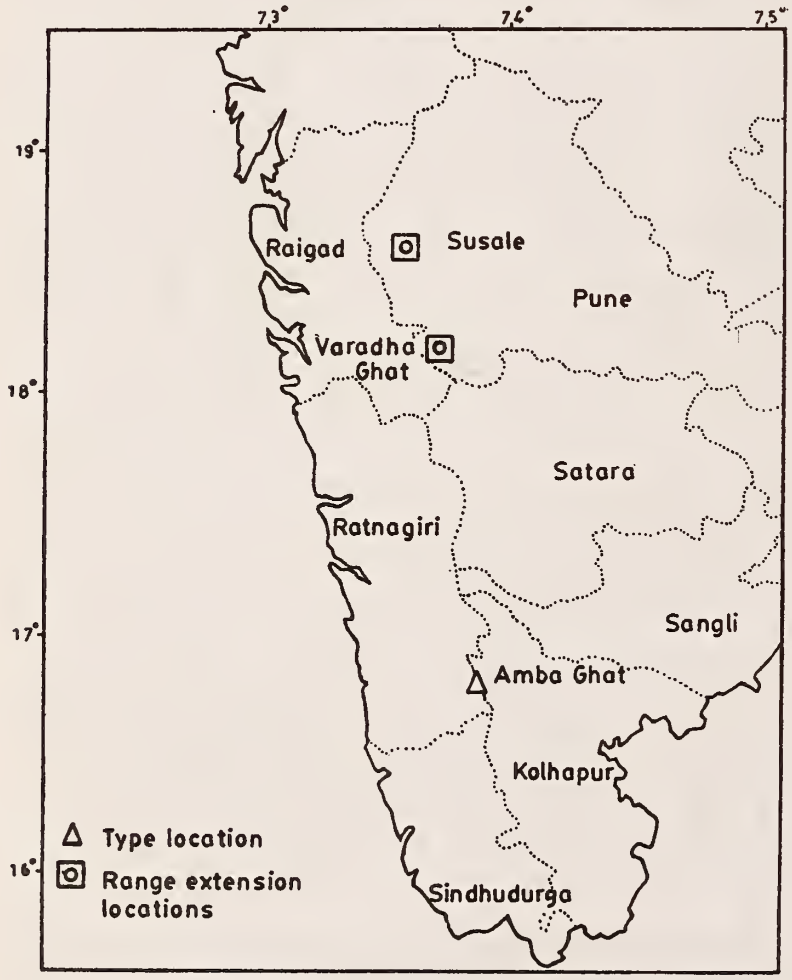

Fig. 1. Distribution of *Ceropegia huberi* in Maharashtra.

Detailed morphological observations on specimens collected from Varandha Ghat as well as Susale island showed distinct variations from original description of the type species (Ansari 1968), as listed in Table 1.

A scrutiny of the Herbarium index at the Botanical Survey of India, Western Circle, Pune and scanning of literature (Ansari 1968, 1984, Nayar and Sastry 1987) revealed that the species is so far known only from the type locality of Amba Ghat, Ratnagiri district, Maharashtra. The type material, however, could not be examined.

The habitat of the species, associated flora and the altitude range (Table 2) are more or less identical at the three locations reported so far. This indicates the possibility that this species occurs in similar habitat range all along the crest line. The linkage, however, has not been traced between the locations reported till now, probably because of inaccessible habitats and ephemeral nature of the species.

Nearly 60 years elapsed between the first two collections and about 23 years between the second and recent collections. Occurrence of the species at type location for more than 60 years indicates its survival, although it is limited in range. The species has been described as vulnerable in the Red Data Book of Indian Plants (Nayar and Sastry, loc. cit.) due to destruction of its habitat from natural causes like landslides during monsoon or man-made causes. Its restricted and sparse distribution indicates its rarity and due care must be taken to protect the plant and its habitat.

ACKNOWLEDGEMENTS

We thank the Director, M.A.C.S. Research In-

TABLE 1
VARIATIONS IN CHARACTERS OF *Ceropegia huberi*

	Original description (Ansari 1968)	Variations recorded in recent collections
1.	Tuber large, up to 4.5x4 cm, globose.	Tuber small up to 2.3x2.5 cm.
2.	Stem up to 2 m, branching terete, glabrous.	Stem up to 1 m, sparsely hairy.
3.	Leaves opposite, petiolate; petiole up to 3.5 cm long, glabrous with minute glands on either side at base; lower leaves acuminate, 12.0x4.8 cm, upper linear-lanceolate, 5.0x1.5 cm; lamina subcoriaceous, margins ciliolate, gland dotted.	Petiole up to 1 cm long, without glands on either side; all leaves linear-lanceolate with slightly broad base; lamina pale green, glaucous beneath, sparsely hairy on upper surface, without gland dots along margins.
4.	Flowers white in lateral subumbellate cymes; peduncle up to 16 cm long, hirsute; pedicels pubescent, 1.5 cm long, corolla forming a circular flattened head.	Peduncle size variable from 4 cm to 16-18 cm, glandularly hirsute; pedicels smaller in size, less than 1 cm long, few pedicels in umbel develop secondary umbels in inflorescences.
5.	Fruits in paired follicles, ± 6 cm long, tapering at both ends, glabrous.	Follicles 8-10 cm long.
6.	Seeds many, ± 5 x 3 mm, ovate, oblong, prominently margined, coma ± 10 mm long.	Seeds 20-25 per pod, 6x3 mm, compressed, with distinct recurved margins.

TABLE 2
DETAILS OF COLLECTIONS OF *Ceropegia huberi*

	Collection	Collector	Period/year	Locality	Habitat/altitude
1.	Original Cooke's collection	Shevde	1909	Amba Ghat	Rock crevices at ± 650 m altitude
2.	Topotypic collection	Ansari	1967	—	—
3.	Recent collection from other areas	(i) Sane	1990	Varandha Ghat	Vertical rock crevices at ± 750 m altitude
		(ii) Vartak	1991	Susale Island, Mulshi area	Vertical rock crevices at ± 675 m altitude

stitute and Principal, Abasaheb Garware College, Pune for facilities. Thanks are due to authorities of Four Eyes Foundation and Botanical Survey of India, Western Circle, Pune for providing material from Susale island and herbarium facilities respectively. We are grateful to Dr V.D. Vartak and Dr M.S. Kumbhojkar for encouragement and valuable suggestions.

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34. AN EARLY COLLECTION RECORD OF *PARTHENIUM HYSTEROPHORUS* L. FROM BOTANIC GARDEN, CALCUTTA

The present note is made to confirm the earlier known centre of migration of *Parthenium hysterophorus* L. (Asteraceae) in India. It is a dangerously noxious weed creating a menace throughout India, particularly in agricultural lands. While identifying Asteraceae members in the Central National Herbarium (CAL) we came across an irreparable historical herbarium sheet labelled as 'Herb Sulphiz Kurz'. Among other incorporations in the sheet are botanical name of the plant written in English in ink and 'H.B.C., Rao (1956), while describing this plant as a new record for India, has probably through oversight missed the material (he specified all other materials except this). The annotation of the sheet reveals that the plant was growing in the Royal Botanic Garden (now Indian Botanic Garden) at Calcutta. Wilhelm Sulphiz Kurz collected the specimen in 1863 as one of the representatives for the work on Flora of Bengal. However, its introduction in the Royal Botanic Garden in 1810 (*Hortus Bengalensis*, p. 62) could not be confirmed from the available specimen. The widespread belief that it was a recent introduction through American food grain import can thus be ruled out, although the route for its original migration to India is not definite.

This plant has now almost acclimatized to the different altitude, climate and soil conditions in India as reported by various authors: Roxburgh (1814), Voight (1845), Chatterjee (1939), Rao (1956), Chandra (1971), Bennet *et al.* (1978), Rao *et al.* (1979), Maiti and Guha Bakshi (1981), as an escapee from gardens. Apart from its various other hazardous effects as a cosmopolitan weed, the only important use attributed to this plant is that a decoction of its boiled roots was used against dysentery by Koasati (Uphof 1959).

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35. ON DESIGNATION OF ILLUSTRATIONS AS TYPES

The purpose of this note is to illustrate the confusion created by designating a figure as the type of a species and complicating the simple nomenclature of some important plants.

Article 7 of the International Code of Botanical Nomenclature (ICBN) necessitates selection of nomenclatural types. In cases of species and intraspecific taxa, a nomenclatural type of a taxon is a single specimen. The most effective of these is the holotype or a single specimen designated by the author at the time of description of the species. The code emphasises the importance of the holotype, lectotype and neotype in descending order. Only if no material is available or existent for designating the neotype, the use of the description or figure as a substitute for the type is allowed. It is significant that no special terminology has been used in the code for typification based on description and figure, because these can be used as types only if no material at all is available for designating a holo, lecto- or neotype.

However, in recent years, it is observed that taxonomists use unpublished drawings and iconographed illustrations as types of various species and intraspecific taxa. As these drawings and illustrations are usually made after careful study of the material described, they no doubt form the most important part of the protologue of the species, but they cannot be called the types of the species. Article 9.3 of the ICBN states, "If it is impossible to preserve a specimen as the type of a name of a species or infraspecific taxon or if such a name is without a type specimen, the type may be a description or figure". It is therefore clearly understood that as long as there are specimens available to designate a lectotype or neotype, the figure cannot be considered as type. I would like to give the following example to clarify the matter.

While placing *Dracontium paeoniifolium* Dennst. in the genus *Amorphophallus*, Nicolson (*Taxon 26:* 338. 1977) united *Arum campanulatum* Roxb. with that taxon for the simple reason that both these taxa included Rheede's 'Mulenschena' among the original protologues. However, protologue of *Arum campanulatum* Roxb. contains much more material than Rheede's figure alone. Because Roxburgh's original description included citation of Rheede's figure, it is incorrect to conclude that it is synonymous with *Dracontium paeoniifolium* Dennst. It is true that Rheede's figure is the common element in the protologues of the taxa. But in case of *D. paeoniifolium* Dennst. it is the only reliable part of the protologues in the process of selection of the type; whereas in the case of *Arum campanulatum* Roxb. there are various parts of the protologue available such as Roxburgh's own figure, his description of the species, localities of distribution, etc., in addition to Rheede's figure/description.

Therefore, Rheede's figure can be only considered as one part of the original protologue of *Arum campanulatum* Roxb. Further, Decaisne has excluded it from Roxburgh's protologue while transferring the taxon to the genus *Amorphophallus*. Thus, it is inappropriate to use the figure in selection of the lectotype of that species, when other more important parts of the protologue are available. Since Roxburgh had not indicated any type specimen for his species, Decaisne was perfectly justified in selecting a type specimen for the species, which he did. Therefore, the choice of the selection of type was exercised by Decaisne and his choice should be followed. Thus, redesignation of Rheede's figure as the type is not only unethical but also superfluous.

As a result of retypification of *Arum campanulatum* Roxb., considering Rheede's figure as type, all the relevant parts of Roxburgh's original protologue have been neglected and placed under *A. campanulatum* sensu auct., non Roxb., 1820, nom. illegit. While affecting this retypification, earlier opinions of not only Decaisne but also of Hooker (Bot. Mag. 55: t. 2812. 1828) and Wight (Icon. Pl. Ind. Orient. 3:5, t. 782. 1844) have been overlooked.

The correct citation for Roxburgh's species should be *Arum campanulatum* Roxb. (pro parte, excl. cit. Rheede). It should not be *Arum campanulatum* auct., non Roxb., 1820. Including Roxburgh, all the subsequent authors have described the species which can be construed in the true sense of *Amorphophallus campanulatus* (Roxb.) Decaisne (excluding the citation of Rheede's figure).

In my opinion, the example cited in the ICBN (ed. 1983) under Article 48.1 is somewhat biased and therefore contrary to the rules of the code. (This example given in the code states, "The name *Amorphophallus campanulatus* published by Decaisne was apparently based on *Arum campanulatum* Roxb. However, the type of the latter was explicitly excluded by Decaisne and the name is to be cited as *A. campanulatus* Decaisne, not as *A. campanulatus* (Roxb.) Decaisne"). I consider the example biased for two reasons. (1) It is based on the wrong assumption that the figure of Rheede referred to under *Arum campanulatum* Roxb. is the type of the species. As Rheede's figure has been excluded from remaining protologue of the taxon by Decaisne, it cannot be redesignated as the type of the species. The correct type or the lectotype of the name is therefore Gaudichand - s.n. (P) (see *Taxon 26:* 337. 1977). (2) The name proposed by Decaisne was a new combination based on *Arum campanulatum* Roxb. and therefore under Article 55.2 of the code should be cited as *Amorphophallus campanulatus* (Roxb.) Decaisne.

Recently, Sivadasan (*Taxon 32:* 128 & 130. 1983) has shown that both the taxa considered by Nicolson are not really the same but differ in certain characters and should be retained distinct at varietal level. Actually these plants are quite distinct and were figured and described by Van Rheede in Hortus Malabaricus separately. Roxburgh's species was known to him as 'Schena' which is an edible corm yielding species very often cultivated; whereas his "Mulenschena" which was named *Dracontium paeoniifolium* by Dennst. is a wild plant found only in southern India. Both of these taxa are still known under their originally mentioned vernacular names.

Unfortunately, both the species are leafless when in bloom and sterile when in leaves. I have seen both species in flowering condition and in the leafy state and I am inclined to consider them as distinct species.

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36. ADDITIONS TO THE TERRESTRIAL FLORA OF LAKSHADWEEP

The last contribution to the flora of Lakshadweep group of islands was made by Wadhwa (1960), who added 11 species of flowering plants, mainly sedges and grasses, to the existing list. However, one of the grasses, *Digitaria adscendens* (HBK) Henrard, reported by him as a new record was already listed by Prain (1894), who had made major contributions to the botany of these islands.

During a brief visit to Lakshadweep in January 1991 I spent four to six hours at each of three islands, Kalpeni, Kavarati and Minicoy. Easily identifiable known plants were recorded and wherever identity of a species was not confirmed in the field, herbarium specimens were collected, and subsequently identified at Blatter Herbarium, Bombay. All the voucher specimens are deposited in the Blatter Herbarium.

After identification of the specimens collected, and a review of the literature, it appears that a checklist for Lakshadweep stands at 236 species of flowering plants (182 dicotyledons and 54 monocotyledons), three species of Pteridophytes (two ferns and one *Psilotum*), one species of moss, two species of lichens, seven species of fungi and two algae. All the islands abound in sea-weeds during winter. However, there is a lack of published work and there is therefore much scope for study on the marine algal flora. So far only 27 species of seaweeds have been identified and reported.

The species listed in Table 1 were observed during my visit and have not been reported earlier.

J. Stanley Gardiner (1906) in his list of plants of Chagos, Maldives, Minicoy & Laccadives mentioned 359 species of flowering plants. The following species which appear in his list from Maldives and Chagos but not from Laccadives and Minicoy were also observed during the present study.

Among the 37 species recorded as new to Lakshadweep there is the likelihood that the following 18 species (about 50%) have been introduced by man..

Annona squamosa L., *Averrhoa carambola* L., *Barringtonia asiatica* (L.) Kurz, *Brugmansia suaveolens* (HBK) Pers., *Casuarina equisetifolia* Forst, & Forst, *Delonix regia* (Boj.) Raffin, *Dodonea viscosa* (L.) Jacq., *Euphorbia heterophylla* Linn., *Euphorbia tirucalli* L., *Leucaena leucocephala* (Lamk.) De Wit., *Lycopersicon lycopersicum* (L.) Karst., *Nerium indicum* Mill., *Plumeria rubra* L., *Solanum melongena* L., *Thevetia peruviana* (Pers.) K. Schum., *Tinospora sinensis* (Lour.) Merrill, *Catharanthus roseus* (L.) G. Don and *Zizyphus mauritiana* Lamk.

The 11 species mentioned below might have been distributed through the agency of birds: *Alysicarpus vaginalis* (L.) DC., *Argemone mexicana* L., *Borreria repens* DC., *Ficus racemosa* L., *Hyptis suaveolens* Poit., *Lantana camara* L. var. *aculeata* L., *Muntingia calabura* L., *Peperomia pellucida* (L.) H.B.K., *Sida acuta* Burm. f., and *Synedrela nodiflora* (L.) Gaertn.

The following three might have been carried by wind: *Emilia sonchifolia* (L.) DC., *Tridax procumbens* L. and *Laggera aurita* (Willd.) Schult-Bip.

It is possible that five species might have come through sea currents: *Aegialitis rotundifolia* Roxb., *Cordia tectonifolia, Crotalaria pallida* Ait., *Pemphis acidula* Forst & Forst and *Cerbera manghas* L.

Some geologists believe that the landmasses presently known as South America, Africa, Deccan plateau of India, Australia, Antarctica, Malagasy, Tasmania and Philippines belonged originally to a large continent named Gondwanaland.

It is said that the oceanic currents in the Indian Ocean complete a cycle of water currents during the course of a year. Warm water-currents run from India, via Lakshadweep and Maldives towards Africa (Mozambique) passing through Malagasy island. Later cold currents flow in the reverse direction from Africa to Australia, cross Tasmania and New Zealand, and are then directed towards India after

TABLE 1
ADDITIONS TO THE TERRESTRIAL FLORA OF LAKSHADWEEP

Name of the species 1	Family 2	Localities 3	Habitat/Specimen No. 4
Alysicarpus vaginalis (L.) DC.	Fabaceae	Minicoy	Among grasses (MRA : 54)
Casuarina equisetifolia Forst & Forst	Casuarinaceae	Kavarati, Minicoy	Planted
Cerbera manghas Linn.	Apocynaceae	Kavarati, Minicoy	Planted (MRA : Photo)
Cordia tectonifolia	Boraginaceae	Minicoy	Sandy coast (MRA : Minicoy 60)
Crotalaria pallida Ait.	Fabaceae	Kavarati	Sandy coast MRA : 74
Euphorbia tirucalli Linn.	Euphorbiaceae	Kavarati	Hedge plant
Euphorbia geniculata Ortega	Euphorbiaceae	Kavarati	Waste-land MRA: Kavarati 99
Ficus racemosa Linn.	Moraceae	Kavarati	Probably planted
Hyptis suaveolens Poit.	Laminaceae	Minicoy	Weed of waste-land MRA: Minicoy 28
Laggera aurita (Willd.) Sch.-Bip.	Asteraceae	Kavarati, Minicoy	Weed MRA : 22
Lantana camara L. var. *aculeata* (Linn.) Moldenke	Verbenaceae	Kalpeni, Kavarati	Weed
Leucaena leucocephala (Lamk.) de Wit	Mimosaceae	Kavarati	Planted
Lycopersicon lycopersicum (L.) Farwell	Solanaceae	Kavarati	Waste-land
Muntingia calabura Linn.	Elaeocarpaceae	Kavarati	Planted MRA : 100
Nerium indicum Mill.	Apocynaceae	Kavarati	Hedge plant
Pandanus leram Jones	Pandanaceae	Minicoy	Sand binder MRA : Photo
Peperomia pellucida (L.) H.B.K.	Piperaceae	Minicoy	Weed
Ophiuros ruvicatulus Steud.	Poaceae	Kalpeni & Minicoy	Weed MRA : 7, 67.
Plumeria rubra L.	Apocynaceae	Kavarati	Planted
Synedrela nodiflora (Linn.) Gaertn.	Asteraceae	Kavarati, Minicoy	Weed MRA : 95
Tinospora sinensis (Lour.) Merr.	Meninspermaceae	Kavarati	Planted
Tridax procumbens Linn.	Asteraceae	Kavarati, Kalpeni	Weed
Annona squamosa L.	Annonaceae	Kavarati	Cultivated
Argemone mexicana Linn.	Papaveraceae	Kavarati	Weed
Averrhoa carambola Linn.	Averrhoaceae	Kavarati	Planted
Barringtonia asiatica (L.) Kurz	Barringtoniaceae	Minicoy	Planted
Borreria repens DC.	Rubiaceae	Kavarati	Weed, MRA : 91
Brugmansia suaveolens (H.B.K.) Pers.	Solanaceae	Kavarati	Waste-lands
Catharanthus roseus (L.) G. Don	Apocynaceae	Kavarati, Minicoy	Planted ?
Delonix regia (Boj.) Raffin.	Caesalpiniaceae	Kavarati, Kalpeni	Planted as ornamental tree
Dodonea viscosa (L.) Jacq.	Sapindaceae	Minicoy	Hedge plant, MRA : 31
Emilia sonchifolia (L.) DC.°	Asteraceae	Kavarati	Among grasses
Pemphis acidula Forst & Forst	Lythraceae	Minicoy	Coastal sands, MRA : 72
Sida acuta Burm. f. var. *chhapgarii* var. nov.	Malvaceae	Minicoy	Among grasses, MRA:57, 57A
Solanum melongena Linn.	Solanaceae	Minicoy	Cultivated
Thevetia peruviana (Pers.) K. Schum.	Apocynaceae	Minicoy	Planted
Zizyphus mauritiana Lamk.	Rhamnaceae	Kavarati, Kalpeni	Waste-lands

passing through Indonesia, Andaman islands and Sri Lanka. The distribution of some of the following species which are rather rare or totally absent on mainland India, is attributed to the oceanic water-currents. However, definite proof is not available.

1. *Hernandia nymphaefolia* (Presl.) Kubitzki (Syn. *Baisolettia nymphaefolia* Presl.)
2. *Messerschmidia argentia* (L.f.) Johnstone (Syn. *Tournfortia argentia* L.f.), MRA : Minicoy-69.
3. *Cyperus pachyrhizus* Nees ex Boek.
4. *Thuarea sarmentosa* Pers. (Syn. *T. involucrata* R. Br. ex Roem. & Schult.) MRA: Minicoy - 32.
5. *Pandanus leram* Jones (MRA : Photograph).
6. *Ophiuros ruvicatulus* Steud. MRA : Kalpeni-7; Minicoy 67.
7. *Aegiatilis rotundifolia* Roxb. MRA: Kalpeni-19; Minicoy-77.

Some of the noteworthy species observed during the visit are: (1) *Cerbera manghas* Linn.— This species, which is planted near residential areas some distance away from coastal waters and tidal swamps, has remarkably large oblong-ovate leaves and is altogether a different form from the mainland plants.

(2) *Catharanthus roseus* (L.) G. Don — This species has not been reported by earlier authors. It is found growing in abundance at Kalpeni and Minicoy in private compounds and in waste-lands and might have been brought in for cultivation for its medicinal alkaloids, which are allegedly useful in the treatment of cancer.

(3) *Sida acuta* Burm.f. var. *chhapgarii* var. nov.—A *Sida* variety closely allied to *Sida acuta* Burm. f. but differing from the typical variety in having broadly ovate-lanceolate leaves with stellate, on both the surfaces and one of the corolla lobe much extended. Found at Minicoy island. As this is not found in the literature it is proposed here as a new variety of *Sida acuta* Burm. f. and named after Dr B.F. Chhapgar, an eminent marine biologist and the leader of the study group.

Sida acuta Burm. f. var. *chhapgarii* var. nov. similis varietati typica differt tamen foliis ovato-lanceolatis stellato-tomentosus et und-corollo-lobo plus extend. Typus : M.R. Almeida - 57 lectibus ad Minicoi.

A complete list of flowering plants is available for reference at BLAT and BNHS in folder of type materials of *Sida acuta* Burm. f. var. *chhapgarii.*

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37. ADDITIONS TO THE GRASSES OF BIHAR

While scrutinising the grasses collected from various parts of Bihar, we came across six taxa, viz. *Brachiaria deflexa* (Schumach.) Hubb., *Eragrostis atrovirens* (Desf.) Trin. ex Steud., *E. pappiana* Chiov., *Setaria viridis* (L.) P. Beauv., *Phalaris arundinacea* L. var. *picta* and *Stenotaphrum secundatum* (Walter) Kuntze var. *variegatum* which have not been reported earlier from Bihar (Haines 1925, Bor 1960, Banerjee and Pal 1970, Jain *et al.* 1975, Banerjee and Naskar 1984). *Stenotaphrum secundatum* var. *variegatum* has not been recorded from India (Naithani 1990). The identity of all the specimens have been confirmed at Central National Herbarium (CAL) except *Phalaris arundinacea* var. *picta*, which was confirmed at Royal Botanic Gardens, Kew, England.

The present note gives up-to-date nomenclature, a brief description, distribution, ecology and critical notes wherever necessary. All the cited specimens are deposited in the Bhagalpur University Herbarium.

Brachiaria deflexa (Schumach.) Hubb. ex Robyns in Bull. Jard. Brux. 9 : 177. 1932; Bor in Gr. Burma, Ceyl., Ind. & Pak. 281. 1960.

Annual, up to 50 cm high. Culms geniculately ascending, pubescent at nodes. Leaf-blades 8-15 x 0.6-0.8 cm, linear, pubescent, acuminate; ligules ciliate. Panicles up to 12 cm long; spikes 5-10, 4-5.5 cm long, pubescent. Spikelets 3.5-4 mm long, turgid, pubescent; pedicels up to 8 mm long. Lower glume 1.8-2 mm long, broadly ovate, 5-7 nerved, pubescent, subacute. Upper glume 3.5-3.8 mm long, membranous, 5-7 nerved, pubescent. Lower lemma 3-3.3 mm long, empty, 3-5 nerved, pubescent, acute, paleate. Upper lemma 1.8-2.2 mm long, hermaphrodite, ovate, crustaceous, 3-nerved, transversely rugose; palea similar. Stamens three; anthers 1.2 mm long. Caryopsis up to 2 mm long.

Flowers: August-December.

Distribution: Throughout India; tropical Africa.

Ecology: Open grasslands; frequent.

Specimens examined: Mirzachowki (Sahibganj district), *N.N. Das* 3386; Dumka (Dumka district), *N.N. Das* 2780.

The plant resembles *Brachiaria ramosa* (L.) Stapf from which it can be easily separated by the hairless pedicels and rhachis and loosely scattered spikelets.

Eragrostis atrovirens (Desf.) Trin. ex Steud. Nom. Bot. ed 2. 1 : 562. 1840; Bor in Gr. Burma, Ceyl., Ind. & Pak. 503. 1960.

A tufted perennial, up to 1.2 m high. Leaf-blades 2.5-7 x 0.3-0.5 cm, linear, bearded at mouth; ligules membranous. Panicles up to 30 cm long, ovate to oblong. Spikelets 2-5 mm long, linear, grey or purple, 9-16-flowered, breaking up from below upwards. Glumes 1.2-1.8 mm long, ovate-oblong, 1-keeled, keel scabrid. Lemmas 1.2-1.5 mm long, 3-nerved, acute; palea deciduous, scabrid. Stamens three, anthers 0.5-0.8 mm long. Caryopsis up to 1 mm long, red-brown, cylindrical.

Flowers: August-November.

Distribution: Throughout India; tropical Africa to South Africa and Malaysia.

Ecology: In wet places, along river and stream banks; common.

Specimens examined: Kathikund (Dumka district), *R.R. Jha* 6281; Gandhigram (Godda district), *R.R. Jha* 7002; Rajmahal, *Mokim* 1510 (CAL).

The plant shows similarity to *E. gangetica* (Roxb.) Steud. Bor (loc. cit.) states that in most Indian herbaria *E. atrovirens* is identified as *E. gangetica*. Some workers distinguished them on the basis of habit, i.e. annual and perennial; however, these characters are insufficient. The two may be easily differentiated on the basis of number of stamens, the former having three stamens and the latter only two.

Eragrostis pappiana Chiov. in Ann. Ist Bot. Roma 8: 371. 1908; Bor in Gr. Burma, Cey., Ind. & Pak. 511. 1960.

Annual, up to 30 cm high. Leaf-blades 3.5-7 x 0.25-0.6 cm, linear, rolled, acuminate; sheaths sparsely bearded at mouth. Panicles up to 10 cm long, oblong, effuse, glabrous. Spikelets 0.5-2.5 cm long, linear, up to 60-flowered; pedicels up to 2 mm long. Glumes subequal; lower 1-1.2 mm long; upper 1.2-1.5 mm long, 1-nerved. Lemmas 1.5-2.2 mm long, scabrid on keels; palea deciduous, keel scabrid. Lodicules 2, stamens 2-3; anthers 0.5-1 mm long, light yellow. Caryopsis up to 1 mm long, dark brown.

Flowers: September-December.

Distribution: INDIA: Bihar, Maharashtra, Rajasthan, Uttar Pradesh; eastern Asia.

Ecology: In dry sandy soils; grows in association with *Eragrostis temula* Hochst. ex Steud.; rare.

Specimens examined: Barchopmor, near Pathargama (Godda district), *R.R. Jha* 7020.

Eragrostis pappiana and *E. tremula* grow together and resemble each other in general appearance of the inflorescence and spikelets. However, *E. pappiana* differs from *E. tremula* in having shorter pedicels (not more than 2 mm long) and narrower, acute lemma.

Setaria viridis (L.) P. Beauv. Ess. Agrost. 51.177.178. 1812; Bor in Gr. Burma, Ceyl., Ind. & Pak. 365. 1960.

Annual. Culms up to 30 cm long, erect, glabrous, turning rosy-red when mature. Leaf-blades 8-15 x 0.5-0.7 cm, linear to linear-lanceolate, minutely scabrid on both surfaces, base narrow, margins scabrid, apex acuminate; ligules ciliate. Panicles up to 2.5 cm long, cylindrical, not lobed or interrupted; bristles 3-9, up to 7 mm long. Spikelets 2.5-3 mm long, elliptic-oblong, light pink, deciduous. Lower glume 1-1.5 mm long, 1-3 nerved, acute. Upper glume 2-2.5 mm long, elliptic-oblong, 5-7 nerved, obtuse. Lower lemma similar to upper glume, epaleate. Upper lemma 2.5-3 mm long, hermaphrodite, crustaceous, smooth, apiculate; palea similar. Stamens 3, anthers 3-5 mm long. Caryopsis up to 2.2 mm long.

Flowers: August - October.

Distribution: INDIA: Bihar, Maharashtra; cooler parts of the Old World.

Ecology: Weed of cultivated fields, on hills and in mixed forests; rare.

Specimens examined: Asanbani (Dumka district), *N.N. Das* 4224.

Superficially the plant is similar to *Setaria glauca* (L.) P. Beauv. and *S. italica* (L.) P. Beauv. but it can be differentiated by the presence of deciduous spikelets, spikes not lobed or interrupted and upper lemma smooth.

Phalaris arundinacea L. var. **picta** Sp. Pl. 1: 55.1753; Bor in Gr. Burma, Ceyl., Ind. & Pak. 616. 1960.

Perennial with creeping stolons, up to 20 cm high. Culms simple, slender, glabrous, nodes covered with membranous, compressed, glabrous leaf-sheaths. Leaf-blades 5-15 x 0.5-0.8 cm, linear, glabrous, acuminate, longitudinally banded green and cream.

Distribution: INDIA: Arunachal Pradesh, Bihar; widely distributed in the temperate parts of the northern hemisphere.

Ecology: Grows in rock crevices in mixed forests and in gardens; rare.

Specimens examined: Madhupur (Deoghar district), *T.K. Pan* s.n.; Bhagalpur (Bhagalpur district), *R.R. Jha* 7376.

Although the variegated leaves are very attractive the plant is not grown widely in Indian gardens. Bor (l.c.) has reported it to be growing in the garden of Govt. House, Shillong and possibly elsewhere, as an ornamental plant. The plant propagates vegetatively as it fails to bear flowers.

Stenotaphrum secundatum (Walter) Kuntze var. **variegatum**; Graf in Exotica ser. 4. vol. 2. 1316. 1985.

Perennial with creeping stolon. Culms flat, glabrous. Leaf-blades 5-20 x 0.3-0.9 cm, linear, narrowed at base, apex rounded, prettily banded creamy-white; sheaths loose, compressed, hairy at mouth, margins hyaline; ligules short, ciliate.

Distribution: U.S.A., tropical America.

Ecology: In sandy soils under shade, often cultivated; rare.

Specimens examined: Bhagalpur (Bhagalpur district), *R.R. Jha* 7369.

This variegated American grass is newly introduced in India for ornamental purposes. This plant also does not bear flowers. It has not earlier been reported from India (Naithani 1990) and thus forms an addition to Indian grasses.

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38. SOME LITTLE KNOWN AQUATIC PLANTS FROM GARHWAL HIMALAYA

(With six text-figures)

The Garhwal Himalaya has been an attractive resource reservoir of vegetational wealth. Several botanists made floristic explorations in the region from time to time (Hooker 1872-97, Duthie 1906, Rau 1975, Kala and Gaur 1982, Naithani 1984, Polunin and Stainton 1985). During a recent plant exploration we collected some interesting and little known plant species from remote localities. *Nymphaea tetragona* Georgi is a new report to this part of Himalaya and the other plants reported here were rarely collected by previous explorers. Brief descriptions of the little known taxa are given with their localities, occurrence, approximate elevation, and collector's herbarium number.

Plant specimens after proper documentation and identification have been deposited in the Herbarium, Botany Department, H.N.B. Garhwal University (GUH), Srinagar.

Ranunculus trichophyllus Chaix in Vill. Hist. Pl. Dauph. 1: 335. 1786. *R. aquatillis* L. var. *trichophyllus*, Hook.f. FBI. 1: 16. 1872. (RANUNCULACEAE)

An annual, aquatic, floating herb. Stem slender, branched, glabrous, green, up to 50 cm long. Leaves all submerged, 2-4 cm long, capillanceo-multifid, ultimate segments up to 2 cm long in mature plants, leaf-sheath broad, membranous, enclosing stem at the base, continuous up to first division in leaf. Flowers yellow, single from the nodes, pedicellate, pedicel 2-3.75 cm long (in fruit); perianth segments 10 (12), 1 mm long, ovate; stamens 10; carpels 6-15 (20). Achene 1.2-2 mm long, slightly warty.

Flowering and fruiting: August-October.

Distribution: Dalisera lake 3,600 m a.s.l., GUH - 15,357.

Previously, this plant has been recorded from Western Himalaya by Hooker (1872) without any definite locality and by Duthie (1906) from Guge (Tibet). Since then it has not been recorded from this part of the Himalayas.

Nymphaea tetragona Georgi, Reipe. Russ. Reich. 1: 220. 1775. *N. pygmoea* Aiton, Hook. f. FBI. 1: 115. 1872. (NYMPHAEACEAE)

A herbaceous, rooted, submerged, perennial. Rhizome small, covered with leaf sheaths and fibrous roots. Leaves long, petioled, floating, shining above, orbicular oblong with wavy margins, deeply cordate, sagitate with diverging acute or rounded lobes, 4-7 x 4-10 cm. Flowers on long peduncles, 3-4 cm across, flower bud rectangular at the base; sepals four, connate at base, ovate, long pointed; petals 6-8 (10), yellow, elliptic, ovate, acute, cyclic; stamens numerous, strap-shaped, yellow; carpel embedded in fleshy disc, many in whorl. Fruit a berry, enclosed by persisting sepals; seeds many, 1.0-1.5 mm long, black.

Flowering and fruiting: June-September.

Distribution: Benital – Aadibadri 2130 m a.s.l., GUH - 14,062.

Hooker (1872) and Pollunin and Stainton (1985) recorded the plant from Kashmir Himalaya. However, there is no report from Garhwal or the Kumaon Himalaya.

Hippuris vuglaris L. Sp. Pl. 4. 1753; Hook.f. FBI. 2: 432. 1878.(HIPPURIDACEAE)

A rooted, submerged, aquatic herb, perennating by stolons. Stem glabrous, ribbed, flaccid, noded, internodes longer in submerged stem and shorter in emergent stem, up to 1 m long. Leaves in whorl of 6-12, translucent, leaves 0.4-2.6 x 0.05-0.2 cm, linear oblong, acute, sessile, midrib prominent. Flowers tiny, solitary, sessile in axils of leaves on emergent stem, mostly bisexual, sometimes unisexual; perianth none; androecium reduced to single stamen; epigynous; ovary inferior, style one, filiform, situated in groove formed by the lobes of the single anther. Fruit a drupe.

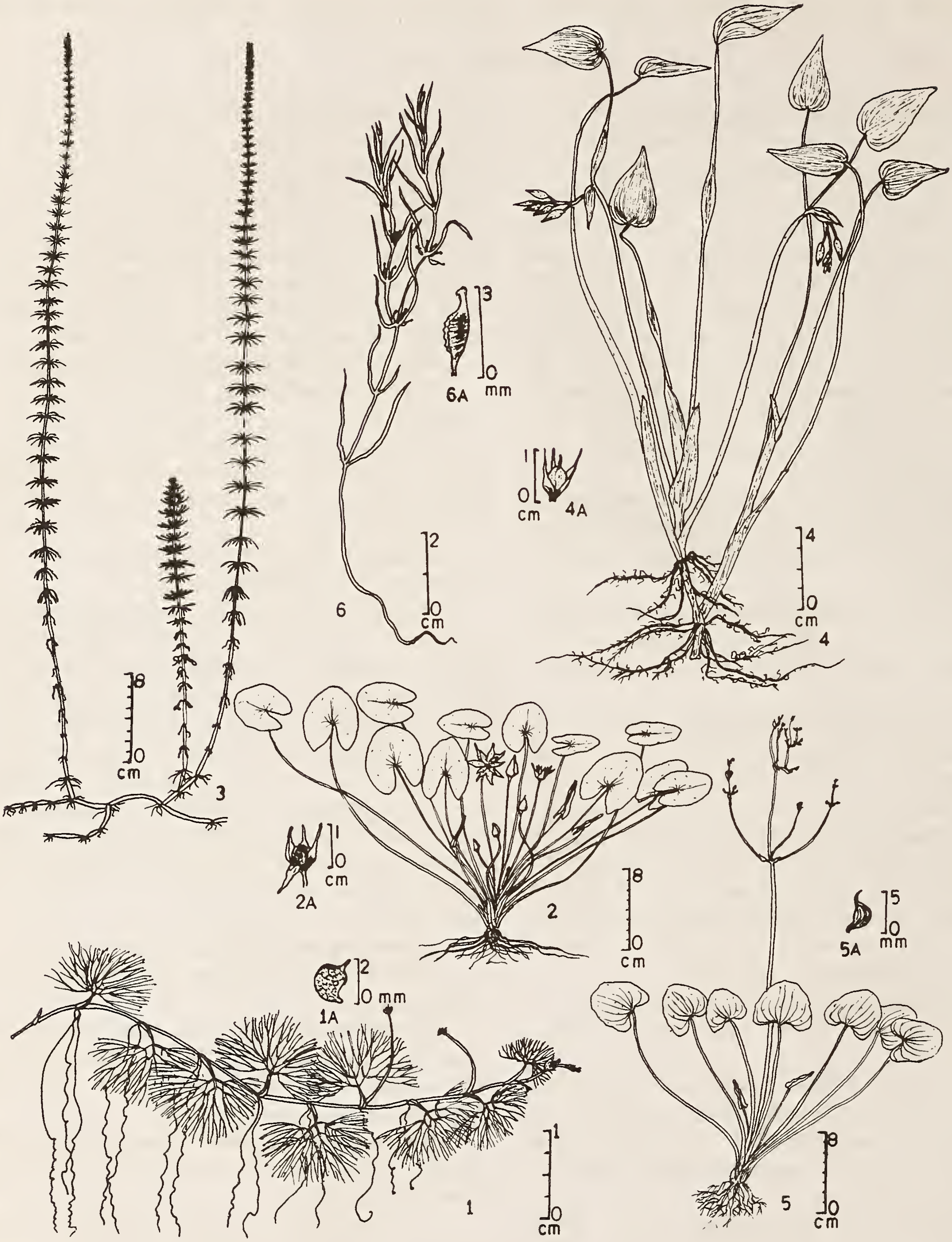
Flowering and fruiting: August-September.

Distribution: Dalisera lake 3,600 m a.s.l., GUH - 13,829.

Previously, this plant has been collected from West Tibet by Falconer, T. Thomson, Strachey and Winterbottom, and by Rau (1975) from Lahul (Himachal Pradesh) and Kashmir.

Monochoria vaginalis (Burm.f.) Presl., Rel. Heank. 1: 128. 1827; Hook. f. FBI. 6: 363. 1892. (PONTEDARIACEAE)

A herbaceous, rooted aquatic perennial. Rootstock sub-erect, branched, rooting at nodes, roots fibrous. Leaves on long petioles, above water surface, ovate-cordate, acute. Flowers on 1-1.5 cm long racemes, peduncles emerging from the sheaths of uppermost leaves. Flowers pedicellate, pedicel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Figs. 1-6. Little known aquatic plants from Garhwal Himalaya.
1. *Ranunculus trichophyllus* Chaix.; 1A. Achene; 2. *Nymphaea tetragona* Georgi; 2A. Fruit; 3. *Hippuris vulgaris* L.; 4. *Monochoria vaginalis* (Burm. f.) Presl.; 4A. Fruit; 5. *Alisma reniforme* D. Don; 5A. Achene; 6. *Zannichellia palustris* L.; 6A. Achene.

0.2-0.8 cm long (in fruiting), flowers blue, spotted with violet; perianth campanulate, outer three green, narrowly obovate, 0.6-1 cm long, inner three lilac blue, 0.5-0.7 cm long; stamens six, one larger, blue, five smaller, yellow; carpel one, stigma 3-lobed. Fruit 0.8 cm long. Seeds many, 0.05 cm long, brown.

Flowering and fruiting: July-September.

Distribution: Benital - Aadibadri 2130 m a.s.l., GUH - 15,143.

An aquatic species of the plains, previously it was recorded from Augustmuni by Naithani (1984).

Alisma reniforme Don, Prodr. 22. 1825. Hook. f. FBI. 6: 560. 1893 (ALISMATACEAE).

An aquatic, rooted, perennial herb. Rootstock small with fibrous roots. Leaves long, petioled, reniform, lobes rounded, nerves 9-11, prominent beneath, leaves shining above, tip rounded or emarginate; scape long, up to 1.0 m long, emerging out of water. Flowers white, 1.0-1.5 cm across, in very large, whorled panicles; sepals three, green, obovate; petals three, white, obovate, membranous, larger than sepals; stamens six; carpels eight or more, not whorled, style sub-terminal. Fruit an achene, black, obovoid, dorsally ribbed.

Flowering and fruiting: August - September.

Distribution: Benital — Aadibadri, 2131 m a.s.l., GUH-15,261

This plant is common in the plains of India. However, only Duthie (1906) reported it from Baiznath in Almora district (Kumaon).

Zannichellia palustris L., Sp. Pl. 969. 1753; Hook. f. FBI. 6: 568. 1893 (ZANNICHELLIACEAE).

A rooted, submerged, aquatic, delicate, silvery shining, up to 31 cm long herb. Leaves opposite, linear, long, 1-5 x 0.05-0.1 cm, tapering to a point, stipules papery, sheathing stem but soon falling. Flowers in axil of leaves, unisexual in a cup-shaped spathe, one male and 2-6 female flowers together, male flowers with one stamen, female flower with one carpel, style long, slender, stigma oblique, peltate. Achene as many as female flowers (2-6), reniform, crested.

Flowering and fruiting : August-September.

Distribution: Dalisera lake 3,600 m a.s.l., in an alpine zone, GUH - 14,616.

This plant has been recorded from salt marshes and lagoons of India by Hooker (1892). Rau (1975) mentioned the availability of this plant in north-west Himalaya without any definite locality.

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39. NEW PLANT RECORDS FOR KARNATAKA

While investigating the flowering plants of Dakshina Kannada (South Kanara) and Shimoga districts of Karnataka, I collected 12 species of plants not previously recorded from Karnataka. The following list gives their correct nomenclature, distribution and flowering and fruiting seasons. The species have been arranged alphabetically. All specimens are deposited at BSI and in the Herbarium of Poornaprajna College, Udupi.

1. **Brachystelma edulis** Coll. & Helmsl. in Journ. Linn. Soc. 28: 89, t. 14. 1890; Yadav *et al.* in J. Bombay nat. Hist. Soc. 86: 480. 1989. (ASCLEPIADACEAE)

Only recently, this species has been recorded in India from Maharashtra (Yadav *et al.* loc. cit.). The present record extends the range of distribution southwards along the west coast of peninsular India. The tubers of this plant are edible. It is locally known as 'Devaragadde', meaning God's tuber.

Flowers and fruits: May.

Exsic.: Dakshina Kannada dist.: Manipal, growing in rocky soil, 15 May 1987, K.G. Bhat 3601.

2. **Capparis floribunda** Wight I11. 1: 33, t. 14. 1831. (CAPPARIDACEAE)

Although there are historical collections of this plant from Malpe area, Udupi taluk (R.S. Raghavan, pers. comm.), there is no record from Karnataka. Not common, seen only in a few places around Udupi, along hedges and in sacred groves.

Flowers: February-March. **Fruits:** April-May.

Exsic.: Dakshina Kannada dist.: Udupi, growing in sacred groves, 5 February 1986, *K.G. Bhat* 1967; Same locality, 20 April 1986, *K.G. Bhat* 1968.

3. **Cleome rutidosperma** DC., Prodr. 1: 241. 1824; Babu & Majumdar in *J. Bombay nat. Hist. Soc. 71:* 631. 1974. (CAPPARIDACEAE)

A frequent weed on roadsides and in waste land in Mangalore and Udupi. This plant appears to be a recent introduction to coastal Karnataka.

Flowers and fruits: More or less throughout the year.

Exsic.: Dakshina Kannada dist.: Udupi, growing in waste land, 12 September 1987, *K.G. Bhat* 7018.

4. **Colocasia affinis** Schott in Bonpland. 7: 28. 1859. (ARACEAE)

In India, this plant is originally known from north-east India. It is common on walls during monsoon season in Mangalore and Udupi. This species seems to be a recent introduction to coastal Karnataka, mostly an escapee from gardens.

Flowers: September.

Exsicc.: Dakshina Kannada dist.: Udupi, growing on walls in shady places; 9 September 1987, *K.G. Bhat* 7014.

5. **Dioscorea pubera** Bl., Enum. Pl. Jav. 1: 21. 1827. *D. anguina*Roxb., Fl. Ind. 3: 803. 1832. (DIOSCOREACEAE)

In India, this yam is so far recorded only from Kerala, Andhra Pradesh, Gujarat and north-east India. A rare plant, collected only once in vegetative condition.

Exsicc.: Dakshina Kannada dist.: Indrali, Udupi, growing in moist shady place in a valley, 1 September 1987, *K.G. Bhat* 7010.

6. **Gymnopetalum cochinchinense** (Lour.) Kurz in J. As. Soc. Beng. 40: 57. 1871. *Bryonia cochinchinensis* Lour., Fl. Cochinch. 595. 1790. (CUCURBITACEAE)

A rare plant, collected only once from Jamlabad fortress, Belthangady taluk.

Flowers: September-October.

Exsicc.: Dakshina Kannada dist.: Jamalabad Fortress, 1500 m Belthangady, 26 September 1990, *K.G. Bhat* 9097.

7. **Lindernia manilaliana** Sivarajan in Kew Bull. 31: 151. 1976. (SCROPHULARIACEAE)

Earlier reported only from Calicut (Kerala). The present record extends the range of distribution along the west coast of peninsular India.

Flowers and fruits: September.

Exsicc.: Dakshina Kannada dist.: Barkur, growing in damp places, 2 September 1990, *K.G. Bhat* 9096.

8. **Rotala malampuzhensis** R.V. Nair ex Cooke in Boissiera 29: 98. 1979. (LYTHRACEAE)

Earlier reported only from Kerala. Common during monsoon in temporary pools and ponds on rocky slopes.

Flowers and fruits: August-September.

Exsicc.: Dakshina Kannada dist.: Udupi, 12 September 1987, *K.G. Bhat* 7018.

9. **Sagittaria guayanensis** H.B.K. ssp. **lappula** (D. Don) Bogin in Mem. N.Y. Bot. Gardn. 9: 192, f. 5. 1955. *S. lappula* D. Don, Prodr. Fl. Nepal. 22. 1825. (ALISMATACEAE)

A rare plant, collected only once, growing in pools during monsoon.

Flowers and fruits: September-October.

Exsicc.: Dakshina Kannada dist.: Alevoor, Udupi, 12 September 1987, *K.G. Bhat* 7020.

10. **Sauropus saksenianus** Manilal *et al.* in J. Indian bot. Soc. 64: 294. 1985. (EUPHORBIACEAE)

This species is so far known only from the type locality, Silent Valley, Kerala state. It is quite likely that this species may occur at many more localities in the evergreen forests of Kerala and Karnataka.

Flowers and fruits: July-August.

Exsicc.: Shimoga dist.: Agumbe, growing in evergreen forest, 14 August 1989, *K.G. Bhat* 8010.

11. **Typhonium flagelliforme** (Roxb. ex Lodd.) Bl., Rumphia 1: 134. 1837. *Arum flagelliforme* Roxb. ex Lodd., Bot. Cab. 4: t. 396. 1819. (ARACEAE)

Grows on roadsides in moist localities in Mangalore and Udupi.

Flowers: September.

Exsicc.: Dakshina Kannada dist.: Udupi, 20 September 1990, *K.G. Bhat* 9080.

12. **Wiesneria triandra** (Dalz.) Micheli in DC., Monogr. Phan. 3: 82. 1881. *Sagittaria triandra* Dalz. in Hook., Jour. Bot. 2: 144. 1850. (ALISMATACEAE)

A rare plant, earlier reported only from Maharashtra. Grows in temporary pools.

Flowers and fruits: September-October.

Exsicc.: Dakshina Kannada dist.: Alevoor, Udupi, 12 September 1987, *K.G. Bhat* 7021.

We are grateful to the authorities of BSI, MH and BLAT for the facilities offered for referring to the Herbaria.

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40. NEWLY RECORDED TAXA FROM ANDAMAN AND NICOBAR ISLANDS

During the exploration of Great Nicobar forest area one of us collected *Ficus* L., *Rhaphidophora* Hassk. and *Thallasia* Banks ex Konig, later identified as *Ficus exasperata* Vahl, *Rhaphidophora eximia* Schott and *Thallasia hemprichii* (Ehrenb.) Aschers, a sea grass. The occurrence of *F. exasperata* Vahl and *Rhaphidophora eximia* Schott in Nicobar islands shows an extended distribution to the Bay island as they are known to occur in central to peninsular India and north to eastern Himalaya including north-east India. The genus *Rhaphidophora* contains only one species in these islands so far, namely *R. laciniata* (Burm.f.) Merr.

Den Hartog (1957) in his treatment of family Hydrochartiaceae for Flora Malesiana, stated that *Thallasia hemprichii* is distributed in E. Africa, Seychelles, Red Sea, Sri Lanka, Malesia to West Pacific (Riu-Kiu islands, Indo-China, New Ireland, New Hanover, New Britain, New Caledonia and Queensland). In India it is known from the coastal region of Tamil Nadu. Jagtap (1985) in his list of sea grasses occurring in Andaman and Nicobar islands included *T. hemprichii* from the Andaman group. Vasudeva Rao (1986) also confirmed the presence of this species in the Andaman islands only on the basis of the literature. This species is not represented in the herbarium at Botanical Survey of India, Port Blair (PBL).

T. hemprichii (Ehrenb.) Aschers has been collected from shallow water on the western coast of Great Nicobar island. The availability of this sea grass towards the extreme southern islands indicates its extended range of distribution.

Rhaphidophora eximia Schott in Bonplandia 5: 45, 1857; Hook. f., Fl. Brit. India 6: 547. 1893. p.p. *R. grandis* Schott in Destr. Bot. Zeitschr 8: 349, 1858. (ARACEAE)

Evergreen, semi-epiphytic, unarmed, climber with fleshy stem. Leaves 40-60 x 10-13 cm, longer than broad, oblong, pinnatisect, obliquely truncate at base, acute at apex, unicostate; lateral nerves 4-7 pairs; petiole very stout, *c.* 20 cm long. Inflorescence axillary, spathe deciduous, 25-30 cm long, oblong, cuspidate, sub-corymbiform, not differentiated into a 'tube' and limb; spadix sessile or subsessile; flowers naked, bisexual, completely and densely covering the spadix. Stamens four, filament strap-shaped. Ovary unilocular, stigma raised on the conical top of the ovary, ovules many, anatropous on two parietal intrusive placentae at base. Berry many-seeded. Seeds oblong to reniform, endospermous.

Flowers: July-September.

Distribution: INDIA – Tropical Himalayas, Kumaon, Khasi hills and Nicobar Islands.

Exsicc.: Andaman and Nicobar Islands: Great Nicobar 40 km N.S. Road, near Galathea river, 28 Sepember 1989, *S.K. Srivastava* 14923 (PBL).

Ecology: Climber on the tree with fleshy stem, growing towards the inland forest in secondary formation.

Thallasia hemprichii (Ehrenb.) Aschers in Petermann's Mitt. 17, 242. 1871; Aschers & Gurke in E. & P. Nat. Pflanzenfam. 2, 1: 254. 1889; Back., Handb. Fl. Java 1: 62. 1925; Sinclair in Gard. Bull. Sing. 14, 35. 1953; Den Hartog in Fl. Malesiana 1: 5, 406. 1957. *Schizotheca hemprichii* Ehrenb. Abh. Berl. Ak. Wiss. 1832, 1 (1834) 429. (HYDROCHARITACEAE)

Roots with longitudinal air-channels, some roots erect with thickened top. Leaves 10-40 x 0.4-1.1 cm. Male plants with 1-2 inflorescence; peduncles in the male plants *c.* 3 cm, those in female plants 1-1.5 cm, after anthesis up to 2-4 cm. Spathal segments lanceolate, acute, apices unequal, entire, persistent, 2-2.5 x 0.5 cm, with many short; brown; male flower pedicellate, pedicels up to 3 cm; female flowers subsessile or shortly pedicelled. Perianth segments revolute, light brown, 0.7-0.8 x 0.3 cm. Stamens 3-12; anthers oblong, occasionally forked, 0.7-1.1 x 0.1-0.13 cm. Ovary 1 cm long, conical, rostrum 2-3 cm long; styles six at one-third from the base, 1.5-2 cm long, split into two filiform arms, each with two longitudinal grooves, curling and caducous after anthesis, light brown. Fruit 2-2.5 x 1.75-3.25 cm, globose, rugose, light green, bursting open with *c.* 20 valves. Seeds 3-9, 0.8 x 0.8 cm, basal portion thickened, dark brown, cotyledons green.

Flowers: December-February. **Fruits:** March-April.

Distribution: Throughout the entire tropical region of the Indian Ocean. East Africa, Seychelles, Sri Lanka, Malaysia, China, Indo-China, New Ireland, New Britain, New Caledonia.

Exsicc.: Andaman and Nicobar islands: Great Nicobar, Near Alexandra river towards east-west, 23 June 1991, *S.K. Srivastava* 21030 (PBL).

Ecology: Growing on muddy coral-sand in sheltered, shallow water on tidal flat in open bay where water and wave action are not so strong. These forms together with other species, e.g. *Gracillaria*, *Amphrioa* and *Helimida* sp. form submarine meadows.

Ficus exasperata Vahl, Enum. Pl. 2: 197, 402. 1806; Corner in Garden Bull. Singapore 21: 74, 1965; Corner in Dassan. & Fosb. Rev. Handb. Fl. Ceylon 3: 274, 1981. *F. serrata* Forsk. Fl. Aeg. Arab. 179, 1775. non L. *F. asperiana* Roxb. Fl. Ind. 3: 554, 1832. (MORACEAE)

Small to medium sized deciduous tree, twigs 0.15-0.8 cm thick, brown. Leaves 11-16 x 5-6 cm, narrowly to widely elliptic, ovate to obovate or oblong-lanceolate, cuneate at base, acute to acuminate at apex, denticulate or sinuate-crenate to serrate at margins, scabrid on both sides, hard coriaceous; lateral nerves 3-5 pairs; petioles 2-4 cm long; stipules short in pair, caducous. Figs axillary, mostly solitary, scabrid, ripening yellow; pedicels 0.4-0.8 cm long with 2-3 small scattered bracts. Male flowers ostiolar, sessile, in 1-2 rings; petals 3-4, oblong-spathulate. Stamens one. Gall flowers sessile to pedicellate; sepals 4-6, lanceolate. Ovary sessile, white, style pink. Female flowers as the gall. Seeds 0.12-0.14 x 0.08-0.1 cm, shortly oblong, slightly keeled, distinctly reticulate.

Flowers and Fruits: July-November

Distribution: INDIA: Central, south India, Nicobar islands; Arabia; East Africa; Sri Lanka.

Ecology: Small tree growing along *Calamus* in inland forests.

Exsicc.: Andaman and Nicobar islands: Great Nicobar, 19 km E-W Road, 24 September 1989, *S.K. Srivastava* 14866 (PBL).

ACKNOWLEDGEMENTS

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S.K. SRIVASTAVA
February 9, 1992 RAMESH KUMAR
Botanical Survey of India, Andaman & Nicobar Circle, Port Blair 744 102

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THE SATPURA HYPOTHESIS: A BIOGEOGRAPHICAL CHALLENGE TO GEOLOGY[1]

Lawrence W. Swan[2]

(With five text-figures)

Key words: Biogeography, Herpetofauna, Himalaya, Sikkim, Garo Hills, Khasi Hills, Mikir Hills, Assam, Satpura Range, Rajmahal Hills, Tibet, Seismology, Earthquakes

The "Satpura Hypothesis" involved a speculation that there had been a mountainous link between the Himalaya and Peninsular India, a concept that was denied by geologists. The present report derives from biogeographical similarities between the eastern Himalaya and the Garo-Khasi-Mikir Hills complex suggesting that these Hills were once situated between the Rajmahal Hills and the Himalaya to provide a mountainous passage for biota between the Himalaya and the Satpura Range. This proposal is supported by geological, seismological and geographical data including the observation that a large rifting has occurred to create the Rajmahal-Garo Gap. The "Assam Thumb" and the "Kashmir Finger" are described to suggest that the Himalaya are being thrust and stretched eastward and northwestward.

The challenge in the title refers to an enigma. The mountain regions of peninsular India are separated from the Himalaya by the Indus-Ganges and Brahmaputra plains because of the historical depression of the Indian Plate along the Himalayan front as it converged upon the Tibetan portion of the Asian Plate. How then have many animals and plants from the mountainous regions of southern Asia managed to cross the plains and populate the mountains of peninsular India? Several explanations have been offered.

The most universally accepted answer assumed that during the various phases of Pleistocene glaciation, the lowered temperatures of the region allowed more temperate forests to range across the plains and create a pathway for montane species to cross the barrier. There are several problems with this explanation, the chief of which concerns the distribution of torrential fishes and frogs that can live only in swift water and could not, in any knowable way, cross the flat lands of the Ganges-Brahmaputra plains. The eggs of such species in this category may have been carried on the feet of birds, a sometimes-used biogeographical excuse that is called upon when all else fails, seems untenable. This is the enigma.

---

[1] Accepted November 1992.

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The biogeographical basis: In 1937, the eminent ichthyologist and zoogeographer Sunder Lal Hora presented what came to be known as the "Satpura Hypothesis" which proposed an extension of the Satpura Range that now crosses peninsular India in WSW to ENE direction. He envisaged a lost mountainous connection between the present terminus of Satpuras, the Rajmahal hills of Bihar, and the Garo-Khasi-Mikir hills (GKM complex) of Assam which lie approximately in line with the Satpuras (Fig. 1). But this Rajamahal-Garo Gap is now 250 km of alluvium through which the Ganges and Brahmaputra make their way to the Bay of Bengal. Geologists denied the existence of any such mountainous feature either recently or in the long past. There just was no residual evidence of these lost mountains. It was now that biologists constructed the alternative route through the Pleistocene forests of the plains.

Hora, however, knew that several genera of torrential cyprinoid fishes, such as *Homaloptera*, *Balitora*, *Bhavania* and *Thynnichthys* with south-east Asian and Himalayan distributions, were also found in the mountains of peninsular India, including the species *Balitora brucei* which was known only from the eastern Himalaya and southern India.

He could not give up on some mountainous connection across the plains. Not being satisfied with the Pleistocene forest solution, he proceeded to grasp at some rather imaginative ideas of how torrential fishes could have crossed these plains. He invoked with seeming desperation, the fact that the sea surface depression during the Pleistocene could have left the land in the Rajmahal-Garo Gap 200 m above sea level so that some fast water could be found in the area (Hora 1951). Eventually, the Pleistocene climatic version of the "Satpura Hypothesis" took root and Hora ceased to publish on his favourite idea after 1953 and in later years even some of his proposals about older Tertiary crossings of fish into peninsular India have been negated by more recent fossil evidence (Sahni 1982).

In 1947 when I was completing my Master's thesis on the distribution of amphibians and reptiles in southern Asia at Stanford University, I received a letter from Hora inquiring if any of my studies had revealed evidence concerning the "Satpura Hypothesis". I answered in the negtive except for the then known presence of 3 montane tortoises and 2 lizards that were common to Parasnath Hill (1463 m) in the Rajmahal Hills and the Darjeeling-Sikkim area of the eastern Himalaya. One of these lizards, *Leiolopisma sikkimense*, is found only in the Rajmahal Hills and the eastern Himalaya (Hora reported on this link in 1949). I assumed at that time (but not now) that such an island population could have been isolated after crossing forested plains. But my studies had indeed revealed that there was an astonishing relationship between the eastern Himalaya and the hills of Assam across the wide Brahmaputra valley (Swan 1947, Swan and Leviton 1962). At that time this knowledge did not seem to relate to the "Satpura Hypothesis," but over the years the Himalayan frogs, lizards and snakes that now live in the hills of Meghalaya kept insisting that their presence there was not accidental.

How could 70% of the montane herpetofauna of the Sikkim-Darjeeling region be found in the Khasi Hills near Shillong? There are 154 species of amphibians and reptiles (41 frogs, caecilians and salamanders, 8 tortoises and turtles, 23 lizards and 82 snakes) in the Sikkim-Darjeeling region (Table 1). Of these species, 52 are found on both the plains and in the mountains

TABLE 1

HERPETOFAUNA OF THE DARJEELING-SIKKIM REGION

SPECIES OF BOTH PLAINS AND MOUNTAINS

AMPHIBIA
1. Bufo stomaticus
2. Bufo melanostictus
3. Microhyla ornata
4. Microhyla rubra
5. Polypedates maculatus
6. Rana cyanophlictis
7. Rana limnocharis
8. Rana tigerina
9.Tomopterna breviceps

TESTUDINES
10. Chitra indica
11. Kachuga dhonkoka
12. Kachuga kachuga
13. Lissemys punctata
14. Trionyx gangeticus

SAURIA
15. Calotes versicolor
16. Hemidactylus bowringi
17. Hemidactylus frenatus
18. Mabuya carinata
19. Riopa albopunctata
20. Sitana ponticeriana
21. Varanus monitor
22. Varanus salvator

SERPENTES
23. Ahaetulla ahaetulla
24. Boiga ceylonensis
25. Boiga cynodon
26. Boiga forsteni
27. Boiga gokool
28. Boiga trigonata
29. Bungarus lividus
30. Bungarus niger
31. Chrosopelea ornata
32. Dendrelaphis tristis
33. Dryophis fronticinctus
34. Elachistodon westermanni
35. Elaphe helena
36. Elaphe radiata
37. Enhydris enhydris
38. Lycodon aulicus
39. Lycodon jara
40. Naja naja
41. Natrix piscator
42. Natrix stolata
43. Oligodon albocinctus
44. Oligodon cinereus
45. Ophiophagus hannah
46. Pareas macularius
47. Ptyas mucosus
48. Python molurus
49. Trimeresurus erythrurus
50. Typhlops braminus
51. Typhlops porrectus
52. Vipera russelli

MOUNTAIN SPECIES CONFINED TO THE SIKKIM-DARJEELING REGION

AMPHIBIA
1. Amolops monticola
2. Ichthyophis sikkimensis
3. Megophrys robusta
4. Philautus argus (1)
5. Philautus dubius*
6. Philautus simus*
7. Rana annandalii
8. Rana gammiei*
9. Rana sinchalensis*
10. Rhacophorus himalayensis*
11. Rhacophorus microdiscus*

SAURIA
12. Cyrtodactylus gubernatoris
13. Japalura andersoniana
14. Japalura tricarinata (2)
15. Japalura variegata
16. Mictopholis austeniana

SERPENTES
17. Ahaetulla prasina
18. Dendrelaphis pictus
19. Dinodon gammiei
20. Oligodon juglandifer
21. Olidodon melaneus
22. Oligodon melazonotu
23. Trachischium guentheri (2)
24. Trachischium tenuiceps (2)
25. Typhlops oligolepis

TABLE 1 (Contd.)

MONTANE SPECIES THAT EXTEND BEYOND THE DARJEELING-SIKKIM REGION

AMPHIBIA

1. Amolops afghanus (5)
2. Amolops formosus (5)
3. Bufo himalayanus (4)
4. Megophrys major *(5)
5. Megophrys parva (5)
6. Philautus andersoni (5)
7. Philautus annandalii (4)
8. Polypedates leucomystax (5)
9. Rana alticola (5)
10. Rana assamensis (4)
11. Rana blanfordi (5)
12. Rana gerbillus (4)
13. Rana leibigei (6)
14. Rana livida (5)
15. Rana sikimensis (4)
16. Rhacophorus bipunctatus (5)
17. Rhacophorus jerdonii (4)
18. Rhacophorus maximus (5)
19. Rhacophorus tuberculatus (4)
20. Scutiger sikkimensis (6)
21. Tylototriton verrucosa (6)

TESTUDINES

22. Geoemyda tricarinata (3)
23. Geoemyda trijuga (3)
24. Testudo elongata (3) & (5)

SAURIA

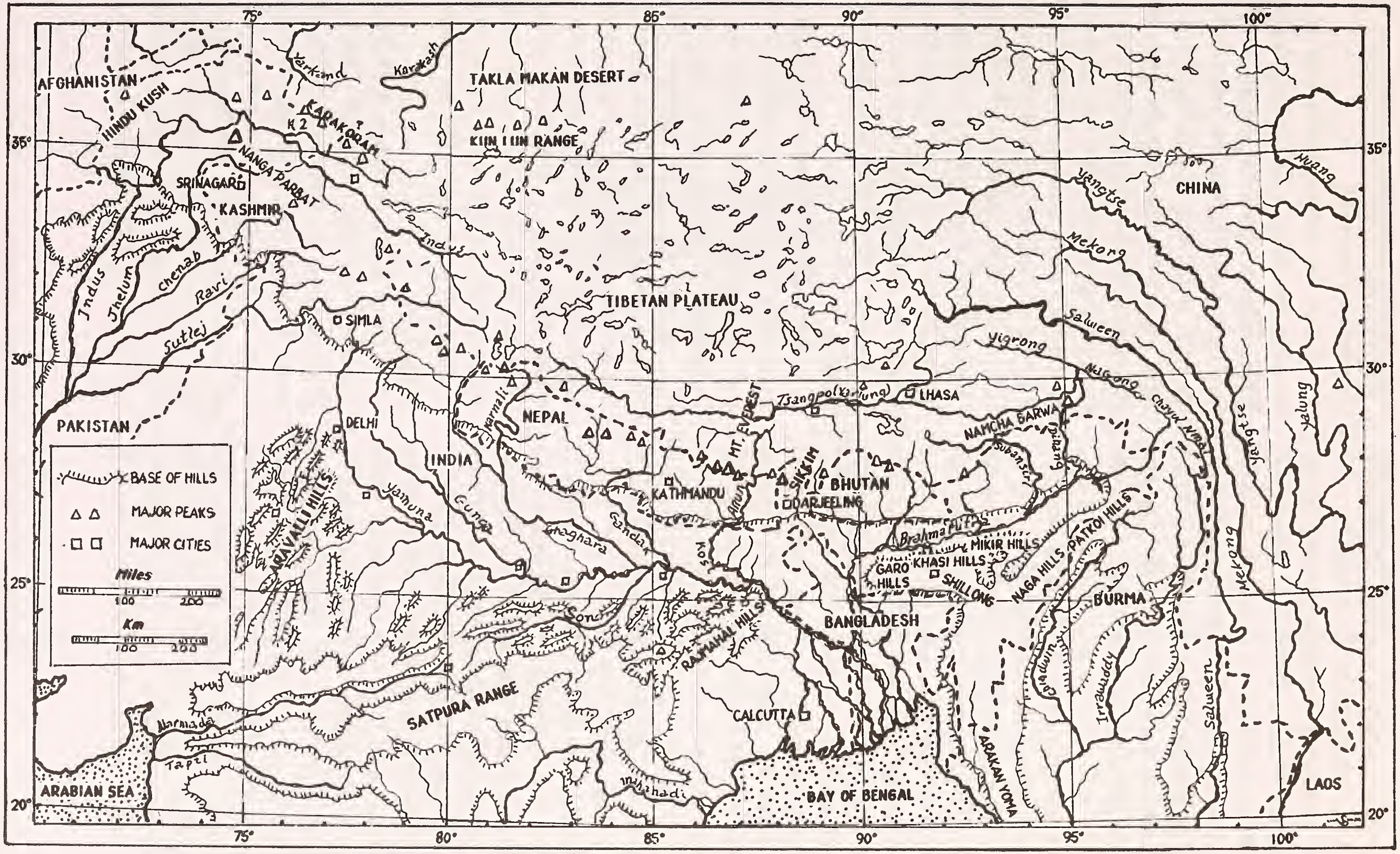
25. Draco maculatus (6)
26. Cosymbotus platyurus (6)
27. Gymnodactylus khasiensis (5)
28. Hemidactylus garnoti (5)
29. Leiolopisma sikkimense (3)
30. Mabuya multifasciata (5)
31. Ophisaurus gracilis (5)
32. Spenomorphus courcyanum (4)
33. Sphenomorphus indicum (5)
34. Sphenomorphus maculatum (3) &(5)

SERPENTES

35. Agkistrodon himalayanus (6)
36. Blythia reticulata (5)
37. Boiga cyanea (5)
38. Boiga multifasciata (6)
39. Boiga ochracea (5)
40. Boiga multifasciata (6)
41. Bungarus bungaroides (5)
42. Callophis macclellandi (5)
43. Dendrelaphis cyanochloris (6)
44. Dendrelaphis gorei (5)
45. Dinodon septentrionalis (5)
46. Elaphe cantoris (5)
47. Elaphe hodgsoni (5)
48. Elaphe mandarina (6)
49. Elaphe porphyracea (5)
50. Elaphe prasina (5)
51. Elaphe taeniura (6)
52. Liopeltis frenatus (5)
53. Liopeltis rappi (6)
54. Liopeltis stoliczkae (6)
55. Lycodon fasciatus (5)
56. Natrix himalayana (5)
57. Natrix khasiensis (5)
58. Natrix parallela (5)
59. Natrix platyceps (5)
60. Natrix subminiata (5)
61. Oligodon erythrogaster (6)
62. Pareas monticola (5)
63. Psammodynastes pulverulentus (5)
64. Pseudoxenodon macrops (6)
65. Ptyas korros (5)
66. Rhabdops bicolor (5)
67. Sibynophis collaris (6)
68. Trachischium fuscum (6)
69. Trachischium monticola (4)
70. Trimeresurus albolabris (5)
71. Trimeresurus monticola (5)
72. Trimeresurus popeorum (5)
73. Trimeresurus stejnegeri (5)
74. Typhlops bothriorhynchus (6)
75. Typhlops jerdoni (5)
76. Typhlops tenuicollis (6)
77. Zaocys nigromarginatus (5)

* Not listed in D.R.Frost (1985). (1) Species extending into neighboring Arunachal Pradesh. (2) Species extending into neighboring eastern Nepal. (3) Species also found in the Raj Mahal Hills. (4) Species confined to the Darjeeling-Sikkim Region and the Khasi Hills. (5) Species in both the Darjeeling-Sikkim Region and the Khasi Hills and elsewhere. (6) Darjeeling-Sikkim species not found in the Khasi Hills.

This listing derives primarily from a review of the scattered literature up to 1947 (L.W.Swan) and checked for Himalayan species in 1962 (Swan and Leviton). The recent synopsis of amphibian species of the world compiled by D.R.Frost in 1985 and a listing of amphibian species of India by R.F.Inger and S.K.Dutta in 1987 allows some corrections in terminology and distribution among the amphibia but there remains no equivalent synopsis of reptiles and, presumably, many additions and deletions could ensue in the future. It should also be noted that the original concentration of species in the Darjeeling-Sikkim region has been diluted with further collections from eastern Nepal and Arunachal Pradesh.


75°
85°
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AFGHANISTAN
HINDU KUSH
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KARAKORAM
NANGA PARBAT
SRINAGAR
KASHMIR
Yarkand
Karakash
TAKLA MAKAN DESERT
KUN LUN RANGE
Indus
Jhelum
Chenab
Ravi
Sutlej
SIMLA
TIBETAN PLATEAU
PAKISTAN
DELHI
INDIA
Yamuna
Ganga
Karnali
NEPAL
Ghaghara
Gandak
KATHMANDU
Kosi
Arun
MT. EVEREST
Tsangpo(Yarlung)
LHASA
SIKKIM
DARJEELING
BHUTAN
NAMCHA BARWA
Subansiri
Dibang
Brahmaputra
MIKIR HILLS
KHASI HILLS
GARO HILLS
SHILLONG
NAGA HILLS
PATKOI HILLS
BURMA
BANGLADESH
RAJMAHAL HILLS
Son
ARAVALLI HILLS
SATPURA RANGE
Narmada
Tapti
Mahanadi
CALCUTTA
ARABIAN SEA
BAY OF BENGAL
ARAKAN YOMA
Chindwin
Irrawaddy
Salween
Mekong
Yangtse
Yalung
Yigrong
Nu Jiang
Chayul Nmai
CHINA
Huang
LAOS
BASE OF HILLS
MAJOR PEAKS
MAJOR CITIES
Miles
100
200
Km
100
200

Fig. 1. Geographical features assoicated with the Satpura Hypothesis.

and are therefore deleted for they could now cross the plains between the two areas.

Of the remaining montane species, 25 are confined to the Sikkim-Darjeeling region and nowhere else so that they are deleted as a factor in this relationship. It is the last category of 77 species of amphibians and reptiles that are found only in mountains but which extend their ranges outside of the Sikkim-Darjeeling region that are considered (Fig. 2 and Table 1). These species, today, can cross only from the Sikkim- Darjeeling area to the Khasi Hills of Shillong by way of mountains. Whereas Shilling and Darjeeling are only some 350 km apart in a direct line, the mountainous connection around the rim of Assam and northern Burma is fully 2000 km. That two ends of extended mountainous system should have such a similarity (54 out of 77 species) seem too much for mere coincidence and even with the possibility of Pleistocene crossings, this sort of wholesale transfer across the plains appears to be too much. Nevertheless, the species similarity suggests a separation that was not too distant in the past and points to a late Pliocene or Pleistocene event.

In looking further into this relationship it can be found that 9 species are confined to only the Sikkim-Darjeeling region and the Shillong area. And to help tighten the correlation between the eastern Himalaya and the Khasi Hills of Shillong, there is the curious association among torrential frogs. At least two species of swift water frogs of the genus *Amolops (Staurois)*, *A. afghanus* and *A. formosus*, whose tadpoles have ventral suckers to prevent them from being washed away and which can only survive in the rapid water of mountains, are common to the eastern Himalaya and the khasi Hills. These more obvious torrential species are accompanied by several other species that can only survive in mountainous streams and could not cross plains, forested or otherwise.

Since the mountainous link of 2000 km between the Sikkim-Darjeeling region and the Khasi Hills remains too distant a relationship, how then could there be such similarity between the ends of this long chain of highlands? Perhaps these ends were closer in the past. Perhaps the Khasi Hills were once adjacent to the Himalaya. Perhaps these hills once lay between the Rajmahal Hills at the eastern extreme of the Satpura Range and connected the Himalaya with peninsular India. Such thoughts could only be a fantasy in Hora's time. Hora's frustration occurred before the advent of Plate Tectonics and a world where not only continents moved but where the land shifts and pushes and remolds its geography.

The Assam Thumb: The GKM complex is composed of the same Archaen basement granitics that form most of India (Fig. 3). It could be interpreted as a segment removed from India or a separate island. Being some 250 km east of the Rajmahal Hills, the terminus of the Satpura Range, the positioning of the GKM complex suggests that it could not have been where it is when India, in its northward movement, approached the remainder of Asia because, to the south, the Arakan Yoma of Burma would deny a northward movement for the GKM complex (Fig. 1).

There is no evidence to indicate that the Arakan Yoma have moved westward or emerged from the Bay of Bengal in the last few million years. It would appear that the folded and parallel ranges of the Arakan Yoma have actually been pressed eastward to correlate with the general eastward thrust of the region. From the geography of the present it would seem that there is no way the GKM complex could have been an

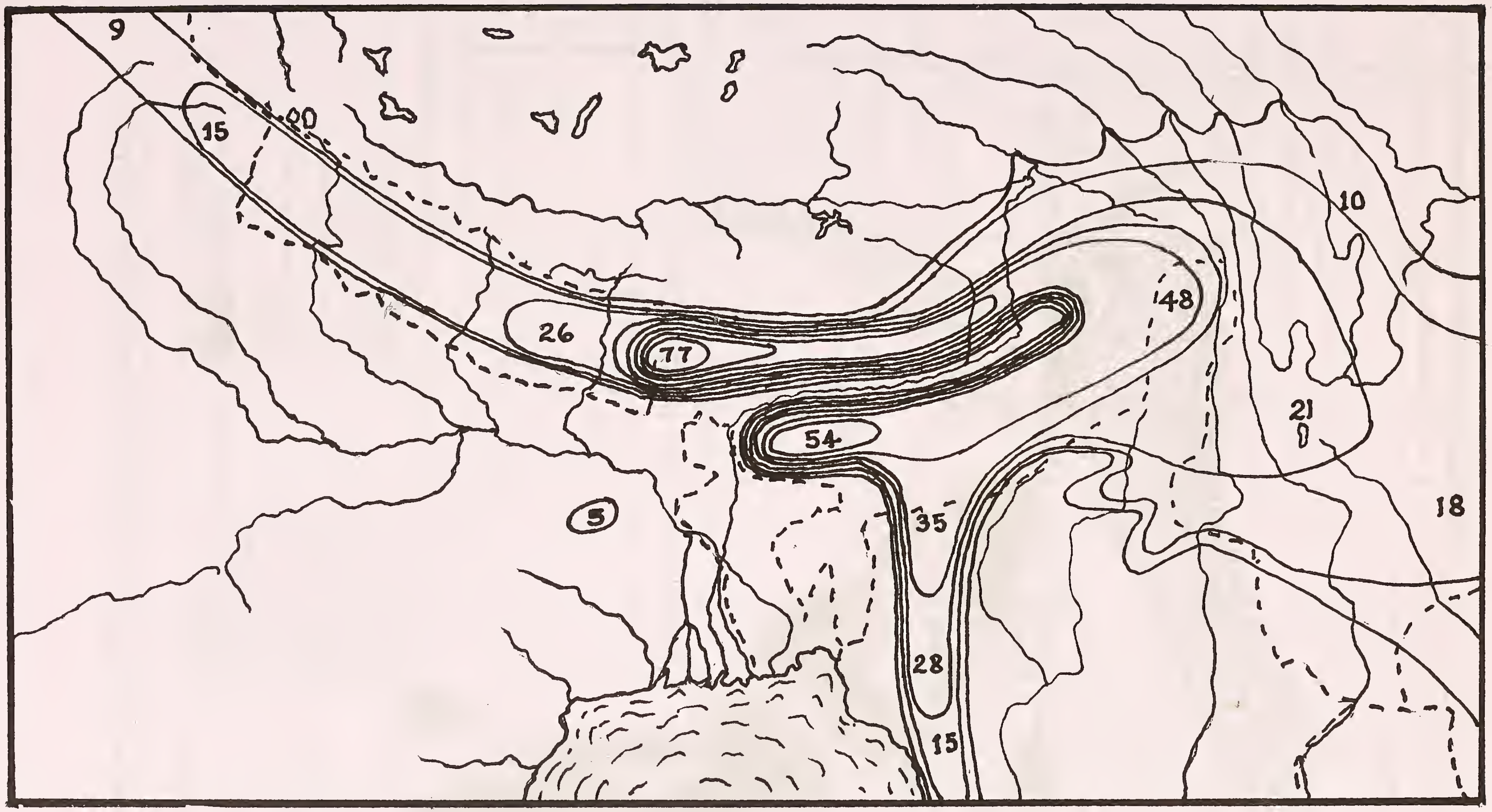
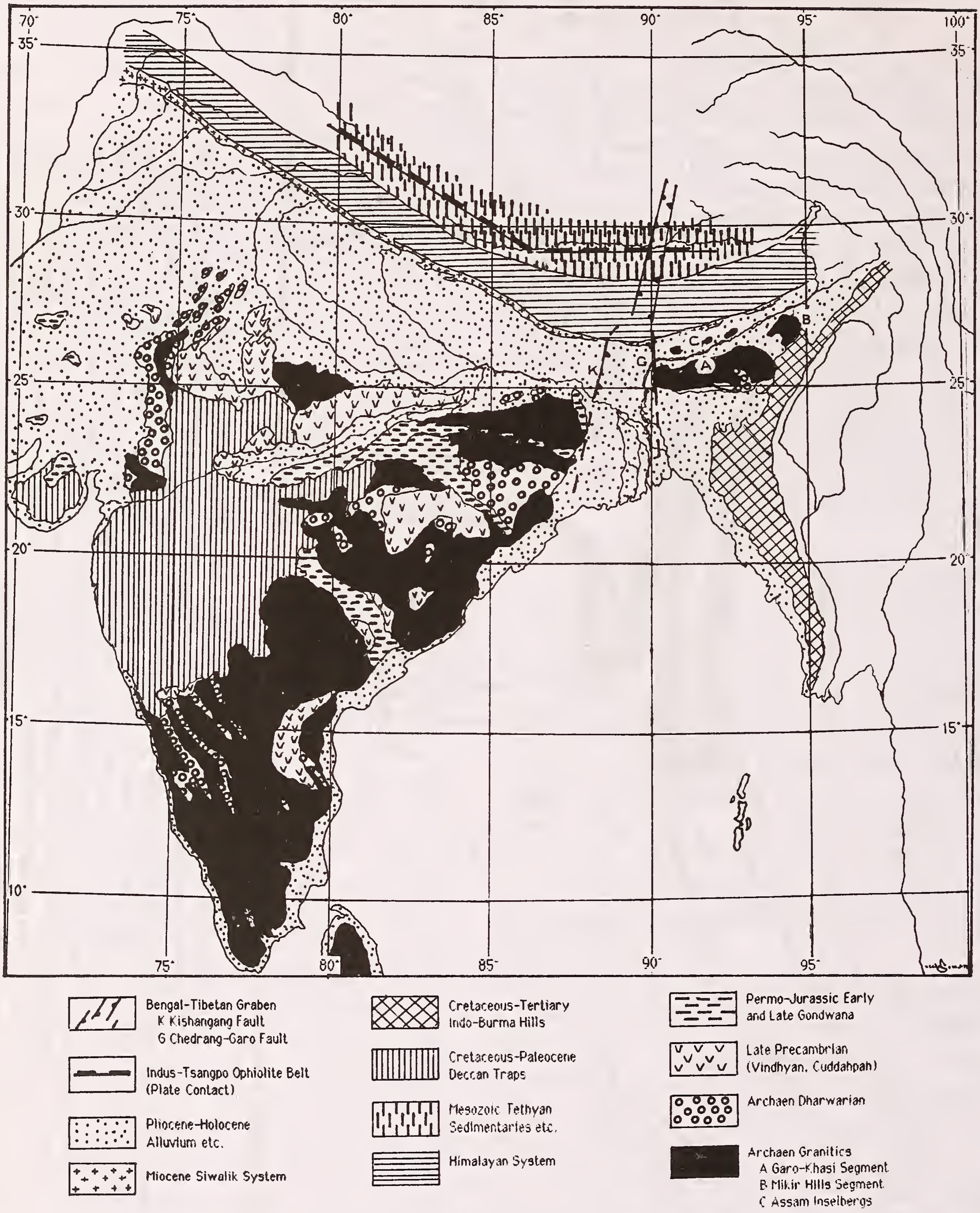


Fig. 2. The distribution of Darjeeling-Sikkim Montane Amphibians and Reptiles.
This region contains 154 species of amphibians and reptiles (41 frogs, caecilians and salamanders, 8 tortoises and turtles, 23 lizards and 82 snakes) in the Darjeeling-Sikkim region. Of these species, 52 are found on both the plains and in the mountains and are therefore deleted for they could now cross the plains between the Himalaya and the Khasi Hills. Of the remaining montane species, 25 are confined to the Darjeeling-Sikkim vicinity and nowhere else so that they are deleted as a factor in the Darjeeling-Sikkim relationship with the Khasi Hills. It is the last category of 77 amphibian and reptile species that are found only in mountains but which extend their ranges beyond the confined Darjeeling-Sikkim area that are here considered. Of these 77 species, 54 have been discovered in the Khasi Hills (9 of these are found only in the Darjeeling-Sikkim area and the Khasi Hills) representing a 70% affinity between two localities that are separated by 2000 km of continuous mountains. Isopleths indicate increased density of 10 species.


70°
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K
G
A
B
C
Bengal-Tibetan Graben
K Kishangang Fault
G Chedrang-Garo Fault
Indus-Tsangpo Ophiolite Belt (Plate Contact)
Pliocene-Holocene Alluvium etc.
Miocene Siwalik System
Cretaceous-Tertiary Indo-Burma Hills
Cretaceous-Paleocene Deccan Traps
Mesozoic Tethyan Sedimentaries etc.
Himalayan System
Permo-Jurassic Early and Late Gondwana
Late Precambrian (Vindhyan, Cuddahpah)
Archaen Dharwarian
Archaen Granitics
A Garo-Khasi Segment
B Mikir Hills Segment
C Assam Inselbergs

Fig. 3. Geology of India simplified to indicate the digression of the Archaen Granitics of Assam.

island and we are left with the supposition that it has broken off the Indian mainland and moved eastward.

In terms of the present geography, if the most eastward portion of the Mikir Hills (93°50′) could pass the most westward extension of the Arakan Yomas (91°10′) in a northward movement, the eastward shifting of the GKM complex would amount to a movement of 290 km (approx. 6 cm per year over 4.8 million years) and the Garo and Khasi Hills would originally have been situated north and adjacent to the Rajmahal Hills of the Satpura Range (to approximately 87°) and fill the gap between the Satpura and the Himalaya.

The Arakan Yoma are aligned in a SSE to NNW direction and this alignment is abruptly altered northeastward into the continuing folded and parallel ranges of the Naga and Patkoi Hills which appear to have been thrust into this configuration by the GKM complex movement. The recency of the GKM complex in its present position is suggested by the lack of sediments at its base. Various strata that in places cover the southern aspect of the Archaen rocks of the GKM complex (Dharwarian, Vindyan and Upper Gondwana etc.) could be related to similar formations overlying the basement formation of the Rajmahal Hills and Bihar (Kumar 1985) although I still await an analysis of the similarity between Bihar and Khasi fossils. I would hope that such a study would be supportive.

If the Garo-Khasi-Mikir Hills (GKM) complex was once contiguous with the Himalaya and connected with the Satpura there would be no outlet for Himalayan rivers into the Bay of Bengal. Therefore a large lake could be hypothesized with a likely outlet via the Son River and the Narmada River to the Arabian Sea (Fig. 1). Wadia (1944) has noted that both these rivers whose headwaters now show a close and broad proximity have extensive sanded and broad alluvial valleys that indicate they were much larger in the past and were most probably joined together to form an outlet for an ancient Ganges to the Arabian Sea. He had no good answer as to why the Ganges would go so far out of its way to find the sea and so the GKM as an extension of the Satpuras to join the Himalaya would also explain this geographical curiosity.

The eastward movement of Assam, the Assam Thumb, involving the GKM complex appears to apply to an eastward shifting of the whole Brahmaputra Valley and the easternmost Himalaya. The Siwalik Hills of Miocene age that fringe the southern rim of most of the Himalaya are, in the eastern Himalaya, scattered and disjoined (Gansser 1964) as if they had been attenuated by a stretching movement. Furthermore, they do not fringe the Himalaya as outlying hills as they do in the more central Himalaya and lie appressed to the main Himalaya so that the Himalaya east of Nepal rise abruptly from the plains. Extensive eastward bending syntaxes characterize the mountains along the eastern rim of Assam and the antecedent rivers of the easternmost Himalaya, such as the Subansiri and the Tsangpo-Dihang-Brahmaputra, are strongly bent into eastward-bending arcs. Both of these large rivers could relate directly with the Chindwin or Irrawaddy Rivers of Burma except for the assumed eastward thrust of the GKM complex.

The eastern portion of the Tibetan Plateau has also shifted eastward (Molnar 1986a, 1986b Armijo *et al.* 1986) perhaps in accompaniment with the Himalayan movement and appears to have so elongated the Tsangpo (Yarlung) River that it has formed large lakes in the past and, with an empty gorge or wind gap linking the Tsangpo and the Arun River (near Lhatze, 87° 40′) may have once flowed westward into the Arun drainage. This is supported by several, large, upstream tributaries of the Tsangpo east of the Arun drainage and a very low down-slope of the river. I have seen this evidence that is amply supported by satellite images.

Relating to the eastward movement of the Himalaya is the phenomenon of a greatly lowered crest-line (Fig. 4) that could be a result of attenuation owing to stretching movements. The depressed altitude is, however, terminated abruptly with the enormous elevation of Namcha Barwa (7753 m) that suggests an accumulative effect as the Himalaya impinge upon the ranges of eastern Tibet.

The eastward thrust of the Assam Thumb has seemingly altered the configuration of the land to the east of it. A most notable feature of the earth, and unique to the earth, is the parallel arrangement of the Salween, Mekong and Yangtse as they emerge from Tibet and are, together, scarcely 60 km apart (Fig. 1) with knife-like ridges separating them that sometimes rise over 6000 m.

It would appear that these giant river gorges have been thrust into close proximity by the eastward movement and that, rather than by the coincidence of the arced and parallel faulting arrangement of this land, the whole region has been squeezed and been pushed eastward. It would seem that this trio of large rivers was once a quartet because the alignment of the Nmai (or Taron) portion of the Irrawaddy with the upper Chayul River and Taron) portion of the Irrawaddy with the upper Chayul River and the Nagong and Yigrong Rivers is remarkable. The latter two rivers of Tibet flow in a common valley directly at each other to join and abruptly flow at a 90° angle into the Tsangpo. This rare arrangement clearly suggests that they were once part of a single river. This ancient Irrawaddy seems to have been broken into 4 portions by the Assam Thumb movement.

The Kashmir Finger: If the Assam movement resembles an eastward thrusting Assam Thumb, then, by analogy, a Kashmir Finger of the "hand" of India thrusts northwestward. The many geographical features that support the existence of an Assam Thumb are duplicated in part by this kashmir Finger as it finally abuts against the Hindu Kush.

The far western Himalaya have a similar depression along the crest line suggesting a spreading, attenuating western movement (Fig. 4). This proposed western movement is similarly capped by an enormous terminus mountain, Nanga Parbat (8108 m), implying an accumulating phenomenon as the Himalaya impinge upon the Hindu Kush just as Namcha Barwa in the east has contacted the ranges of eastern Tibet. The geographical duplication of enormous summits at the two extremes of the Himalaya suggests a common geological process that seems to be related to the east-northwest expansion of the range.

To my mind there are no other mountain ranges of the world with such characteristic pinnacles at each end. Immense syntaxes that bend toward the northwest characterize the geology of the far western Himalaya, and the major rivers of the western Himalaya, the Indus, Jhelum and Chenab are bent strongly westward to mimic the eastward bends of the Subansiri and Dihang. Some of these rivers, presumably, date back to the Miocene with the first broad elevation of Central Asia to antedate the final upthrust of the Himalaya and thus they traverse the present crestline. One would not easily assume that their original courses were bent in this fashion.

PEAKS OF THE HIMALAYA
BETWEEN THE INDUS AND THE TSANGPO-DIHANG

	FEET	METERS	LONG: E.
1. Mt. Everest	29,028	8849	86°50'
2. Kangchenjunga	28,208	8597	88°00'
3. Lhotse	27,890	8500	86°50'
4. Makalu	27,824	8480	87°00'
5. Dhaulagiri	26,810	8171	83°20'
6. Manaslu	26,760	8156	84°30'
7. Che Oyo	26 750	8153	86°30'
8. Nanga Parbat	26,606	8126	74°30'
9. Annapurna I	26,504	8078	83°40'
10. Shisha Pangma	26,291	8013	85°40'
11. Annapurna II	26,041	7937	84°00'
12. Gyachung Kang	25,910	7897	86°13.
13. Nuptse	25,850	7879	86°50'
14. Himalchuli	25,801	7864	84°30'
15. Dakum (Pk 29)	25,706	7835	84°30'
16. Nanda Devi	25,645	7816	79°50'
17. Chomolonzo	25,640	7815	87°00'
18. Ngojumba Ri I	25,611	7806	86°40'
19. Kamet	25,447	7756	79°30'
20. Namch Barwa	25,445	7755	95°00'
21. Dhaulagiri II	25,429	7750	83°20'
22. Gurla Mandhata	25,355	7728	81°10'
23. Janu	25,294	7709	88°00'
24. Dhaulagiri III	25,271	7702	83°20'
25. Makalu II	25,120	7656	87°00'
26. Annapurna III	24,857	7576	84°00'
27. Khula Kangri I	24,784	7554	90°30'
28. Khula Kangri II	24,737	7539	90°20'
29. Changtse	24,730	7537	86°50'
30. Khula Kangri III	24,708	7530	90°20'
31. Khula Kangri IV	24,660	7516	90°20'
32. Gankar Punzum	24,540	7479	90°30'
33. Jonsong	24,518	7473	88°00'
34. Nanda Devi, E.	24,391	7434	79°50'
35. Ganesh Himal	24,299	7406	85°00'
36. Churen Himal	24,158	7363	83°10'
37. Abi Gamine	24,130	7354	79°30'
38. Kabru	24,124	7352	88°00'
39. The Twins	24,114	7349	88°10'
40. Talung	24,112	7 348	88°00'

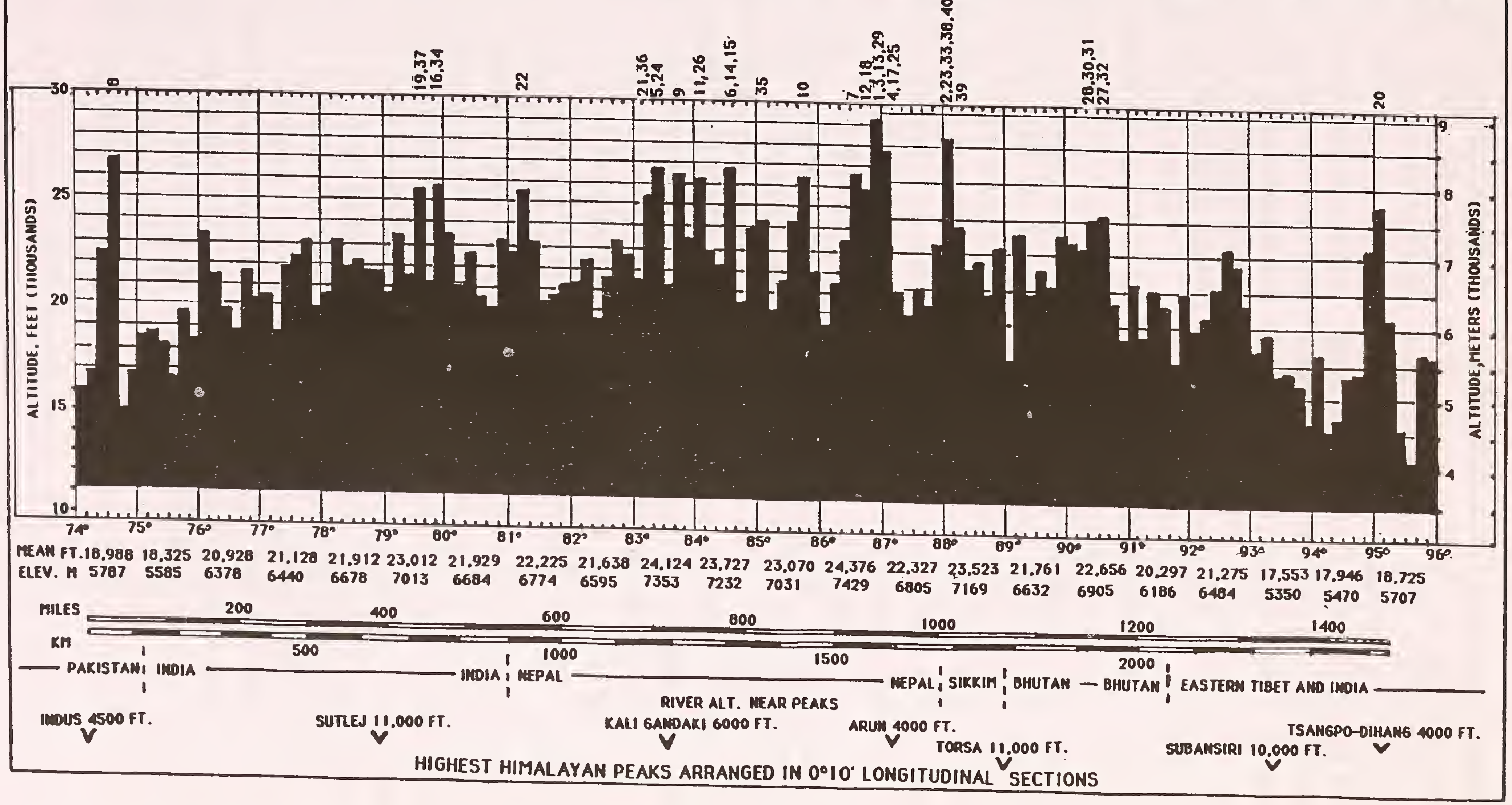


Fig. 4. Highest Himalyan peaks arranged in 0°10′ Longitudinal sections.

Seismic Data: These various observations of spreading thrusts are capped by seismic data that strongly suggest eastward and northwestward movements (Fig. 5). Concentrated knots of both shallow and deep earthquakes coincide at the tips of the Kashmir Finger and the Assam Thumb (U.S. Geological Survey 1974, Teng and Lin 1984). The Hindu Kush zone of deep earthquakes (up to 300 km deep), as well as the northern Burma knot (of similar depth) near Assam, represent a pair of concentrated deep earthquake zones that are unique in that they involve continental lithospheric movements as common rather than sporadic events. In this they strangely resemble localized oceanic crustal subduction.

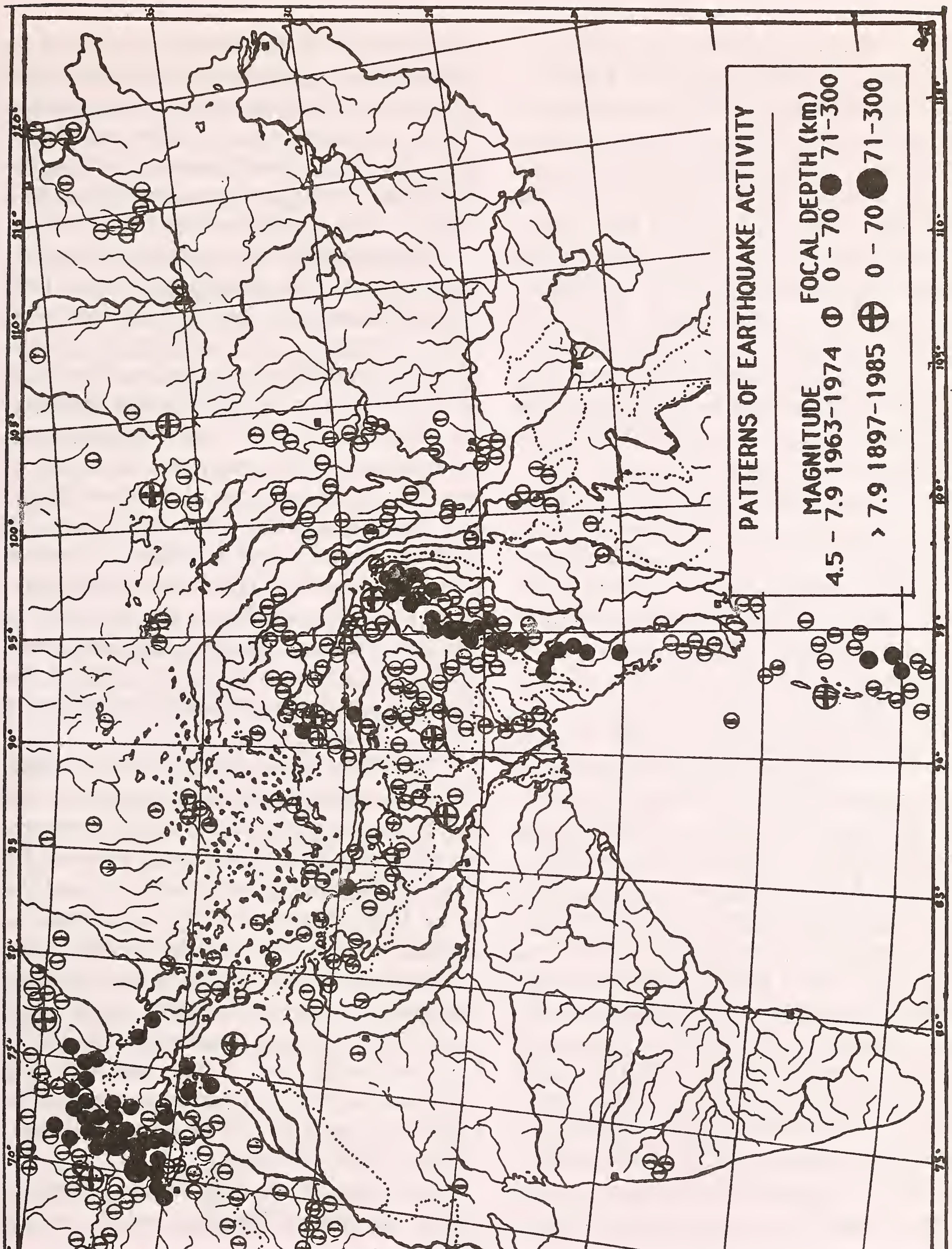
These twin anomalies of ultradeep continental earthquakes appear to be indicative of some as yet overlooked Plate behavior that seems to be related to the spreading activity within the Himalaya. No such deep earthquake zones appear on the northern rim of the Himalaya or along the ophiolite contact region of the Indian and Tibetan Plates that may suggest continued northward abutment pressure of the Indian Plate. It seems odd that there are no frequent deep lithospheric movements along the line of continental contact.

Seismic data reveal that the eastward and northwestward movements may involve a rifting within India that may continue northward far into Tibet (see below). Shallower earthquakes of great strength have characterized the Assam Thumb area, notably the 1951, 8.7 event at the tip of the Assam Thumb in the Chayul Valley and the 1897, 8.7 earthquake at the foot of the westernmost Garo Hills involving the north-south Garo or Chedrang Fault Zone in Assam (Oldham 1899) where fault scarps in the hills of over 10 m in height were recorded and large rocks were thrown into the air (see Oldham's photographs). Oldham, however, points out that much of the earthquake's intensity derived from beneath the alluvium which does not shear to reveal a distinct fault line, and he also indicated that there was evidence of a continuing fault in the Himalayan foothills north of Assam that suggested a north-south series of faults across the whole of the Brahmaputra plains.

The 8.3 intensity, Great Bihar Earthquake of 1934 (an event that was a frightening experience of my childhood) had an epicenter on the plains near the southeast border of Nepal and across the Rajmahal-Garo Gap from the 1897 earthquake. These two giant earthquakes fairly coincide with the eastern and western walls of a presumed graben that now, filled with alluvium, separates the Satpura Range from the GKM complex. Whereas the Great Bihar Earthquake has been interpreted as the result of the northward impingement of India upon the Himalaya, the evidence suggests that this was not the case.

The Bihar earthquake along with a similar Bihar earthquake of 1833 (and a smaller 6.9 Bihar event of 1988) represent the only large earthquakes to occur along the base of the Himalaya, on the plains, in the Archaen Basement beneath the alluvium, in the last 200 years (Delhi, which overlies the submerged Aravalli Hills recorded a large earthquake in 1720). Dunn *et al.* (1939) further indicate that the region of eastern Bihar to western Assam, the zone of the Bengal graben, represents the area of greatest historical damage from earthquakes in India. If such earthquakes represented a continued northward thrust of India one may ask why the rest of the Himalayan front along the plains does not experience large earthquakes?

There exists a great fault zone, the Kishangang Basement Fault, discovered during oil ex-


PATTERNS OF EARTHQUAKE ACTIVITY
MAGNITUDE
FOCAL DEPTH (km)
4.5 – 7.9 1963–1974
0 – 70
71–300
> 7.9 1897–1985
0 – 70
71–300

(After U.S.Geological Survey, 1974, and Teng and Lin, 1984)

Fig. 5. Patterns of earthquake activity.

plorations (Mathur and Evans 1964), that extends between the Himalaya and the Rajmahal Hills, a fault that severs the Archaean basement shield of India and which lies close to the epicenter of the Bihar earthquake (Ni and Barazangi 1984) and the presumed western side of the Bengal Graben. Joining the Kishangang Fault with the Tibetan Fault zone is the earthquake of November 19, 1980, near Darjeeling, that shows a "left lateral strike-slip mechanism to indicate a possible genetic relationship between transverse structural features in the underthrusting Indian Plate and the upper blocks of the Lesser and Tethyan Himalaya and Tibet" (Ni and Barazangi 1984). There are many smaller earthquakes within the Himalaya suggesting smaller movements within the Himalaya, but the only great earthquake occurred in the western Himalaya (Kangra 1905, 8.2) which could well have been the result of the westward rather than a northward movement. It seems that published interpretations of this earthquake are generally contradictory.

The major concentration of earthquakes in Tibet occurs along a line that extends northward from the Bengal Graben. Here there is a smaller graben (the Gulu-Yadong Rift) a few kilometres wide representing the effect of the eastern movement of the Plateau (Tapponier *et al.* 1981a, 1981b). That these two grabens are part of the same process of rifting is open to speculation for, although the Tibetan portion extends into the Himalaya and suggests the distinct hiatus of the Chumbi (Yadong) Valley (note the Himalayan hiatus of the Torsa River, 89°00′-89°10′, Fig. 4) between Sikkim and Bhutan, the intra-Himalayan section between this valley and the Bengal Graben on the plains of India has not been examined. The Darjeeling earthquake is, however, very suggestive of a commonality. It is my contention that the two grabens are indeed related and I can suggest that the Indian Plate with its broader separation perhaps underlies the Tibetan portion that has been more recently affected. A few deeper earthquakes occur along the Tibetan portion suggesting an involvement with a deeper rifting of an underlying Indian Plate.

Zoogeographical Analysis: The great concentration of the herpetofauna in the Darjeeling-Sikkim area that is duplicated with other vertebrate and invertebrate groups reflects its availability to collectors. But this is not the entire reason for its faunal diversity. The Darjeeling-Sikkim region approximates the terminus of the westward expansion of Indo-Chinese species out of northern Burma and Yunnan meeting and overlapping an eastward expansion of a cohort of western Himalayan species. There are, furthermore, some relictual Himalayan species such as *Scutiger sikkimensis* that have remained in isolated localities since the final uplift of the Himalaya and the loss of more pluvial times in Tibet.

The Khasi Hills and the vicinity of Shillong also represent a faunal concentration that reflects the frequency of collections; however, the strong exclusive relationship between the fauna of the Darjeeling-Sikkim area and the Khasi Hills (9 species) has not seemed to diminish in the last 50 years during which time collections have commenced in both the once unavailable Arunachal Himalaya and the more eastern hills of Assam (Inger and Dutta 1987). It is conceivable that, as time and collecting progress, the whole of the eastern Himalaya and the Assam Hills will be united in a common arc of species density.

The cause of the high density of species linking the eastern Himalaya and the Assam

Hills can be interpreted variously. I have supposed, in the past, that a knot of montane fauna emanating out of northern Burma and Yunnan have expanded westward into both a Himalayan arm and an Assam arm where climate and vegetation have been equivalent. With this interpretation, the higher relationship between the tips of these arms, namely the Darjeeling-Sikkim region and the Khasi Hills becomes a problem that seems to rely on its justification upon the lack of information concerning the intervening areas and the hope that, eventually, an equal gradient of species leading out to the two arms would be found.

However, with the geological evidence as presented here, a new and somewhat amazing inference is available. I wish to suggest that the arced distribution of the montane herpetofauna is the culmination of a massive eastward movement of the land that has thrust an earlier northward extension of the Arakan Yoma that once approximated a contact with the Himalaya (in the vicinity of 91°E) far eastward where its remnants remain in the curved and distorted syntaxes of the Mishmi Hills (the site of the great 1951 earthquake). The eastward movement of the GKM complex has, presumably, accompanied this spectacular movement of the earth's surface. The distribution of the herpetofauna around the rim of a new Brahmaputra valley appears like a thumb-like extension eastward (Fig. 2), the recognition of which as a feature of zoogeography long preceded my use of the "Assam Thumb" to denote the geological features of the area.

Concluding statements: There is in this proposed explanation of biogeographical and geological events in Asia an abundance of foci for argument and controversy that may blur its broader truths. Hora's torrential fishes along with much of the mountainous biota of Peninsular India, in my opinion, must have used the now displaced GKM complex as their pathway across the plains. Perhaps the Himalayan loss of contact with peninsular India preceded the loss of contact with the GKM complex because the peninsular relationship with the eastern Himalaya is largely on a generic level while the relationship with the GKM complex remains closely on the species level. The prime theme that warrants my contentions is the necessity to understand this biogeographical enigma of the Satpura connection with the Himalaya where, up to now, geological speculation has been silent except on its impossibility. I am further impressed that the seismologists have not adequately interpreted the twin deep earthquake centers at the eastern and northwestern termini of the Himalaya. These continental (as opposed to oceanic) subduction regions, that are not expressed elsewhere along the Indian-Tibetan contact zone, are unique to the world but yet remain unquestioned in the light of Himalayan Range expansion. Add to this the aligned rifting of the Bengal and Tibetan grabens.

The western Kishangang Fault zône, together with the eastern fault zone associated with the Chedrang Fault of the Garo Hills (with their associated major earthquakes whose >8 intensity areas overlap the rift region of Bengal) that delimit the Rajmahal-Garo Gap, seems to negate a thesis that this Ganges – Brahmaputra region is anything but an immense graben or rift. This graben denotes an eastward shift of the land and accounts for the eastward movement of the GKM complex away from its prior connection with the Satpura Range.

How all this relates to the tectonic oddities that allowed for the GKM complex to move from a Satpura-Himalayan contact to its present location some 290 km east remains to be seen. Somehow the GKM complex was moved eastward after contacting the Himalaya instead of being depressed beneath the Himalaya as were the Aravalli Hills that disappear into the alluvium near Delhi. Perhaps it was too massive to be swallowed into the Himalayan front submergence.

Perhaps the curious inselbergs composed of the Archaen granitics of the Indian Plate that stand above the alluvium of Assam north of the Brahmaputra River between the GKM complex and the Himalaya are the submerging summits of a previous Himalayan contact that was once associated with the GKM complex. Perhaps the northward movement of the Indian Plate itself has reached some impasse that has forced it to move into lateral portions. It is clear that much field work is needed in this region that is marked by huge interest and modest investigation. However, it is my experience that new theories or new outlooks seem to nurture new supporting evidence that may once have been overlooked or misinterpreted in the light of other convictions.

The challenge to geologists is to account for what appears to me to be a legitimate analysis that could solve Hora's old enigma rather than be "geometrically and dynamically impossible" as one geologist critic contended. The strange distributions of animals and plants, as the meteorologist Alfred Wegener once proposed, often reveal equally strange processes of earth movements and I again offer a challenge to geologists to look again at the shapes of rivers, the heights of mountains, the depths of earthquakes and the fascinating geography of Asia.

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ON THE RELATIVE ABUNDANCE OF TWO SYMPATRIC FLYING SQUIRRELS OF WESTERN GHATS, INDIA[1]

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Key words: Flying squirrel, nocturnal arboreal mammals, rodent, *Petaurista petaurista philippensis*, *Petinomys fuscocapillus fuscocapillus*, relative abundance, census method, spot-light transect, distribution, habitat use, encounter rate, Western Ghats

Observations were made on the abundance of two sympatric gliding squirrels, *Petaurista petaurista philippensis* and *Petinomys fuscocapillus fuscocapillus* in two protected areas of Western Ghats, to assess their relative abundance in different vegetation types and the efficacy of methods used for studying nocturnal arboreal mammals. Methods used were night transects and watch tower observations using a spotlight. Deciduous forest and cardamom plantation had higher abundance of *Petaurista* (1.2 and 1.5 squirrels/spot-hour respectively) than evergreen forests (0.7 squirrel/spot-hour). It was low or absent in teak and tea-coffee plantations (0-0.3 squirrel/spot-hour). It was evident from the study that *Petinomys* is not an extremely rare species as presumed to be. While the transect method could assess distribution, abundance and activity pattern, behavioural studies could be possible only by vantage point observations.

INTRODUCTION

Prater (1948) described four species of large flying squirrels (Genera : *Petaurista*, *Eupetaurus*) and four species of small flying squirrels (Genera: *Petinomys*, *Belomys*, *Hylopetes*) in India. Several new species and subspecies have been described later, particularly from the Himalayas (see Saha 1977, Ghose and Saha 1981, Ghose and Chakraborty 1983). For none of these species, there is information on their relative abundance, which would give a picture of their commonness or rarity.

The large brown flying squirrel *Petaurista petaurista philippensis* Elliot and the small Travancore flying squirrel *Petinomys fuscocapillus fuscocapillus* Jerdon are the only gliding mammals of the Western Ghats. While the former occurs throughout the Peninsular India, the latter is restricted to the Western Ghats (Prater 1948). Described by Jerdon in 1874, *P. fuscocapillus* have been collected only thrice; twice 70 years ago (Jerdon 1874, Wroughton 1915) and once recently by Kurup (1989).

Some aspects of flying squirrel ecology have been studied in the south-east Asia (Baba *et al.* 1982, Ando *et al.* 1984, Muul and Lim 1978). Little is known on their biology and ecology in India. Hutton (1947, 1949) briefly described the hole- nesting behaviour, breeding season and seasonal change in the coat colour of large brown flying squirrels. Minette (1947) gave some information on a captive flying squirrel (identified as *Petaurista caniceps*) from Mukteshwar.

This paper is on the relative abundance of flying squirrels (*P. p. philippensis* and *P. f. fuscocapillus*) in different vegetation types of Western Ghats, and the efficacy of the two

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methods used for studying nocturnal arboreal mammals.

The data was collected in Indira Gandhi (formerly Anaimalai) Wildlife Sanctuary (10°13′–10°33′ N, 76°49′–77°21′ E) and Kudremukh National Park (13°5′ –13°30′ N, 75°0′–75°20′ E) during a three month survey (April, May and June 1990) on the status of Malabar civet (*Viverra civettina*) and brown palm civet (*Paradoxurus jerdoni*) (Ashraf *et al.*, in press).

METHODS

Estimating the densities of nocturnal mammals is a difficult task, particularly in the case of arboreal mammals. Their relative abundance could easily be assessed by a simple measure of encounter rate (Kemper 1988), especially if the species in question is common.

The two methods employed in this study were night transects and watch-tower observations using a spotlight. All the observations were made between 1700 and 0600 hrs. Vehicle and foot transects were made depending on the availability of motorable roads. Transect lengths varied from 2 km to 19 km. Most transects passed through several vegetation types. Attempts were made to sample each vegetation type over similar time of night and also the same vegetation at different times of night. Date, time, vegetation type and the number of individuals sighted were recorded for each sighting.

All the sightings were later analysed for encounter frequency (EF) using a simple measure of number of individuals sighted/spot-hour (Kemper 1988). Comparisons were made among moist evergreen forest, moist deciduous forest, teak plantation, cardamom plantation and coffee and tea plantation. For watch tower observations, small temporary wooden platforms were erected near fruiting trees for overnight observations.

RESULTS

Spotlight transects covered a distance of 190 km (including repeated transects in one path) in about 38 spot-hours. Of this, 52.6% was spent in evergreen forest, 18.2% in deciduous forest and 29.2% in plantations (Table 1). Watch-tower observations lasted for 58 hours, spread over eight nights. Almost all observation points were near fruiting trees of *Mangifera indica*, *Knema attenuata*, *Myristica* sp., *Ficus* sp., and *Artocarpus integrifolia.*

Of the 43 flying squirrels sighted during transects and watch-tower observations, 37 were of *P. p. philippensis*, 3 were of the rare *P. f. fuscocapillus* and 3 could not be identified. All observations of *Petinomys* were in the evergreen forests of Anaimalais, during watch-tower observations (Table 2).

The average EF of *Petaurista* was 0.73 squirrel/spot-hour during transects, which differed between vegetation types (Table 1). It was highest in cardamom plantation (1.5 squirrels/spot-hour), followed by moist deciduous forest (1.29 squirrels/spot-hour), evergreen forest (0.7) and other plantations of teak, coffee and tea (0 to 0.3). Almost all the sightings were from a vehicle, except for cardamom where all the three sightings were while walking. Sightings were on 12 different species of trees, besides a number of trees that could not be identified as they were far away from the transect-line for on the spot identification.

DISCUSSION

1. **Relative abundance:** The sightings of *P.f. fuscocapillus* in Anaimalais indicated that it is not as rare as it is considered to be. It is likely to be in a greater proportion than what is revealed

TABLE 1

ENCOUNTER FREQUENCIES OF *P. p. philippensis* IN DIFFERENT VEGETATION TYPES

Vegetation type	Distance travelled (km)	Time spent hours	%	Sighting (No.)	UI* (No.)	EF/spot-hour
Evergreen	101	20.2	52.6	14	2	0.7
Deciduous	33	7.0	18.2	9	–	1.2
Teak	33	6.2	16.1	2	–	0.3
Cardamom	6	2.0	5.2	3	–	1.5
Coffee, tea	17	3.0	7.8	0	–	–

*UI — Species could not be identified.

TABLE 2

RESULTS OF WATCH-TOWER OBSERVATIONS

Species of fruiting tree	Vegetation	Hours spent	Sightings LBFS	TFS	UI
Mangifera indica	Evergreen	21	8	1	2
Knema attenuata	Evergreen	12	–	1	–
Myristica sp.	Evergreen	10	1	1	–
Dillenia pentagyna	Evergreen	4	–	–	–
Ficus sp.	Teak	8	–	–	
Artocarpus integrifolia	Cardamom plantation	3	–	–	–

LBFS — Large brown flying squirrel (*P. p. philippensis*).
TFS — Travancore flying squirrel (*P. f. fuscocapillus*).
UI — Unidentified.

in the present study (3 sightings as opposed to 37 of *P. p. philippensis*). Since none were sighted during transects, the probability of sighting them would have been more if individual trees were thoroughly scanned, as was done during watch-tower observations. Besides its possible natural rarity and smaller size, another reason for the lack of information about this species is the inadequate knowledge to differentiate it from the more common *P. p. philippensis*.

Kurup (1989) obtained a specimen of *P. f. fuscocapillus* from the coconut groves of coastal Kerala. This suggests that there could still be isolated populations of this species surviving in densely populated coastal Kerala. As long as the distance between trees is short enough for gliding, populations of flying squirrels can survive even in villages, unlike the non-gliding squirrels *Ratufa* (Muul and Lim 1978). Moreover, flying squirrels being nocturnal and hole- nesters, the impact of human disturbance would be less than on large diurnal squirrels like *Ratufa*, which build conspicuous globular nests.

P. f. fuscocapillus were observed in the company of several individuals of *P. p. philippensis*. Hutton (1949) reported a similar observation of this species among groups of foraging *P. p. philippensis*. *P. f. fuscocapillus* could be observed for 90 minutes. They were slow in their movements and were not seen feeding, unlike the other species. While at rest and moving on trees (non-gliding), the tail of *Petinomys* was always carried over the back. Hutton (1949) considered this behaviour as a sort of protection.

Encounter frequency (E F) of *Petaurista* in different vegetation types: It is difficult to attribute any reason for the greater abundance of *Petaurista* in deciduous forests than in evergreen forests (1.2 sightings/spot-hour as opposed to 0.7/spot-hour). A study on their feeding habits may provide the answer to this. Spotlighting in evergreen forest was frequently disrupted due to rains, unlike in deciduous forest. Studies on Australian marsupial gliders have shown that their detectability during spotlighting decreased significantly as a function of precipitation (Davey 1990). Among plantations, cardamom had the greatest abundance of squirrels (1.5/spot-hour of walk). This is in spite of the fact that far less area was covered while walking than by vehicle in one spot-hour. The evergreen canopy in cardamom plantation is less disturbed than in coffee and tea plantations. With only 3 sightings of squirrels in 2 hours of spotlighting, it is difficult to project any possible reason for their greater abundance in cardamom. Studies elsewhere have shown that areas which had the highest density of flying squirrels were those which were nearly clear-cut primary forest (Muul and Lim 1978). Kudremukh and Anaimalais would be ideal reserves for further studies on this aspect.

Comparison of methods: It is concluded that spotlighting could be used to assess the abundance, distribution and period of activity of nocturnal arboreal mammals. As disturbance to squirrels when observed from a vantage point was less than during transects, watch-tower observations could be used for behavioural studies.

Estimating absolute densities by spotlight transect using one light as done during this study could lead to an under-estimate for two reasons. Firstly, by using a single beam of light, the observer's attention will be on only one side of the transect at any given period of time. As a result, one is likely to miss many individuals on the other side. Secondly, since the recording is based on the 'eye-shine', there is some probability of some squirrels facing away from the source of light, even though some are likely to turn back towards the direction of 'disturbance'. We suggest that two observers with spot-lights on either side of an open jeep moving at an average speed of 5-10 km/hr would be ideal for an approximate density estimation.

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FRUITING PHENOLOGY AND SEASONALITY IN TROPICAL DRY EVERGREEN FOREST IN PT. CALIMERE WILDLIFE SANCTUARY[1]

P. BALASUBRAMANIAN AND P.V. BOLE[2]

(With nine text-figures)

Key words: Fruiting phenology, Fleshy-fruited plants, Bird-dispersed, *Salvadora persica*

The fruiting phenology of 64 fleshy-fruited plants (27 tree, 23 shrub and 14 climber) were studied for two years. Most of the fleshy-fruited plant species occurred in low abundance, whereas a few were very common. Definite seasonality in fruiting was noticed. Peak fruiting occurred during wet season and fewer species fruited during the dry season. No significant difference was found in the number of species in fruit between the two years. Three seasonal fruiting patterns were identified. 13 species produced ripe fruits during summer and pre-monsoon (dry season). 37 species produced ripe fruits during monsoon and post-monsoon (wet season). 14 species produced ripe fruits in both seasons. Many of the summer fruiting species are either rare or occasional. Seedless fruiting by *Salvadora persica* was recorded. The distribution of fleshy-fruited plants and their fruiting seasonality in various tropical forests was compared with Pt. Calimere.

INTRODUCTION

One of the prerequisites for evolving a management programme for any tropical forest biotope is an understanding of the biology of plant and animal life that manifests the quality of the particular ecosystem. Hence it is essential to know how the plants phase their phenological events in time and space. It is well known that seasonal changes in climate bring about various types of growth patterns in the life of plants. A seasonal climate also brings about fluctuations in animal populations such as pollinators and seed dispersal agents. The importance of biotic factors in the evolution of some tropical phenological patterns has been studied by various researchers in the tropical America (Janzen 1967, Smythe 1970, Snow 1971, Daubenmire 1972, Bawa 1974, Frankie *et al.* 1974, Howe 1977, Heithaus 1979, Howe and Smallwood 1982) and in tropical Africa (Hladik and Hladik 1967, Lieberman *et al.* 1979, Lieberman 1982).

In India, although some research has been done on the general aspects of phenology of plants as well as phenology in relation to climate (Blasco and Legris 1973, Boojh and Ramakrishnan 1982, Shukla and Ramakrishnan 1982, Ralhan *et al.* 1985, Prasad and Hegde 1986, Ansari and Bhadola 1989) no studies have been conducted on the phenology of plants in relation to biotic factors. Therefore, as a part of the study on the plant-animal interrelations at the tropical dry evergreen forest in Pt. Calimere Wildlife Sanctuary (Balasubramanian 1990), data was collected on the fruiting phenology of fleshy-fruited plants.

STUDY AREA

The Pt. Calimere Wildlife Sanctuary (10°18′ N, 79°51′ E) is situated on a low promontory on the Coromandel coast in Nagapattinam (Thanjavur) district, Tamil Nadu (Fig. 1). The Jaffna peninsula of Sri Lanka is about 50 km away across the Palk Strait.

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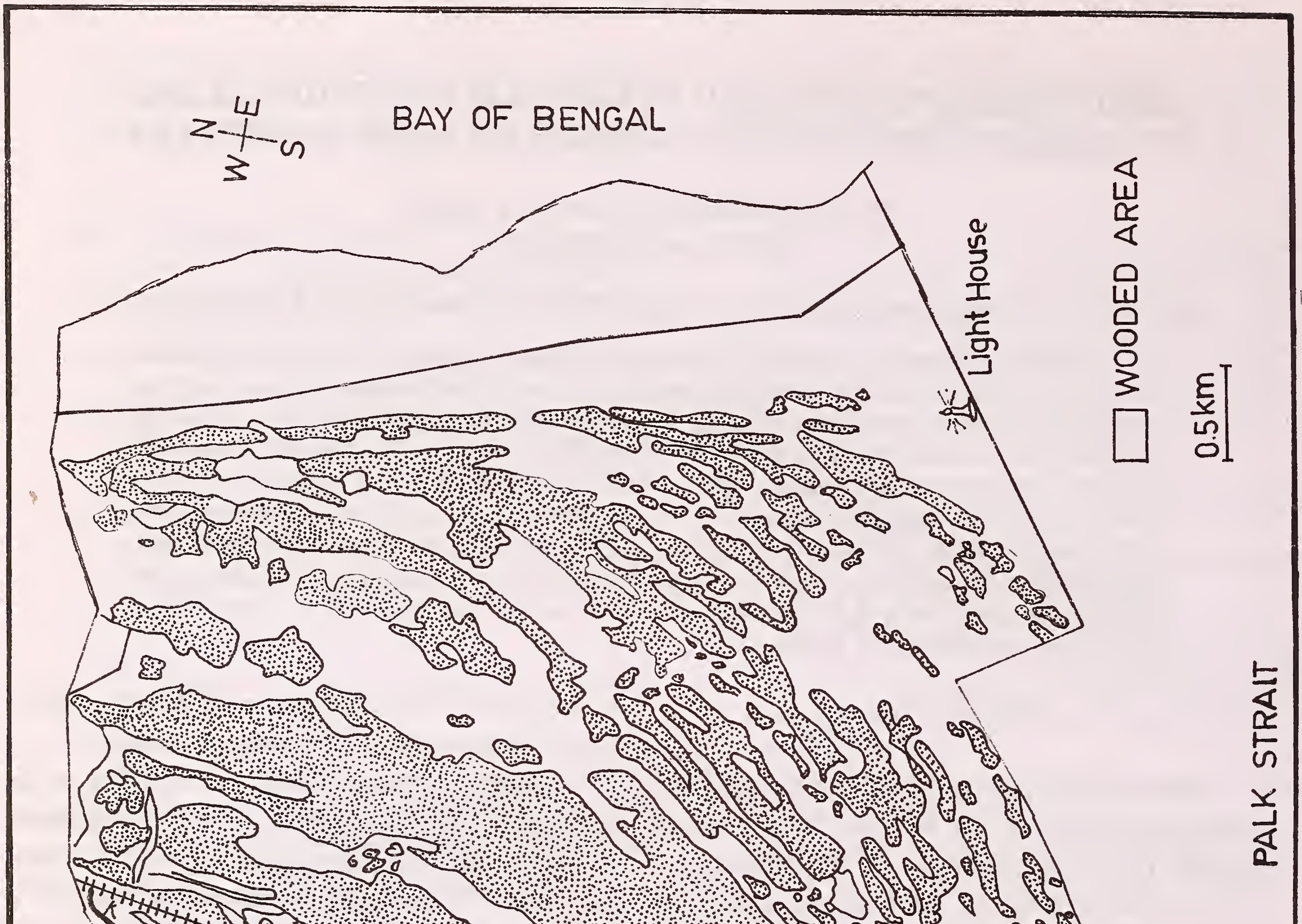
BAY OF BENGAL
N
S
E
W
Light House
WOODED AREA
0.5km
PALK STRAIT
VILLAGE FOREST
KODIKKADU
KODIKKARAI
Point Calimere
India
Road
Railway
Fig.1 Map of Point Calimere Sanctuary

Fig. 1. Map of Point Calimere Sanctuary.

The elevation of the area is 4 m above msl at the highest point of the sanctuary. The sanctuary extends over an area of 2401.38 ha (Varatharaj 1988). The forest is discontinuous, being intersected by numerous open grazing lands. Generally, the upper stratum of the soil is sandy. The coastal plains are formed of alluvial soils which are clayey-silty (Blasco and Legris 1973). There are two distinct seasons in a year — the long dry season and the short rainy season. April, May and June are the warmest months. Heavy rainfall occurs from October to December due to the north-east monsoon (Fig. 2). The yearly total rainfall for six years (1983-1988) ranged from 544 to 948 mm. The average yearly maximum temperature recorded for six years (1983-1988) was 35.7°C and the minimum was 21.8° C (Fig. 3). Pt. Calimere enjoys a dry sub-humid climate (Rao and Sastry 1974). Strong winds are prevalent and the maximum wind velocity of about 68 km/h usually occurs during June and July.

The vegetation of the sanctuary is classified as tropical dry evergreen forest type (Champion and Seth 1968). The flora and vegetation have been studied by Sebastine and Ellis (1967), Blasco and Legris (1973), Balasubramanian (1982) and Balasubramanian (in press). Sebastine and Ellis (1967) who had classified the vegetation of this sanctuary into three categories namely sea-shore vegetation, dry evergreen vegetation and mangrove vegetation. The littoral vegetation is prominent along the sea-shore. Mangrove vegetation is prevalent in low-lying areas, where partial inundation takes place during high tide. Dry evergreen vegetation forms the major vegetation. The forest consists mainly of trees which are small and stunted. The upper canopy can be seen from a height of a few metres.

A total of 18 mammal species are reported from Pt. Calimere. The common mongoose *Herpestes edwardsii* and threestriped palm squirrel *Funambulus palmarum* are the commonest animals of the forest. The jackal *Canis aureus*, blacknaped hare *Lepus nigricollis* and blackbuck *Antilope cervicapra* are also common. Bonnet macaque *Macaca radiata* and chital *Axis axis* have been introduced. Sugathan (1983) reported 137 passerine bird species from the sanctuary. Major frugivorous birds are bulbuls, mynas and koel. Starred tortoise *Geochelone elegans*, garden lizard *Calotes versicolor* and common Indian monitor *Varanus benghalensis* are some of the common reptiles. Insect life is also rich at Pt. Calimere.

METHODS

Climatological information: The calendar year of this tropical region of India is divisible into the following four seasons and the various phenological phenomena of plants at Point Calimere are described based on these seasons. 1. Post-monsoon (January, February and March), 2. Summer (April, May and June), 3. Pre-monsoon (July, August and September) and 4. Monsoon (October, November and December).

Climatic variables for the period January 1983 to December 1988 were collected from the BNHS weather station at Pt. Calimere, which consisted of a Stevenson screen containing maximum-minimum thermometer, and a hygrometer were used. A standard rain gauge was used to measure the rainfall.

Plants: *Definitions* —The following definitions have been adopted after Opler *et al.* (1980) and are used here with slight modifications.

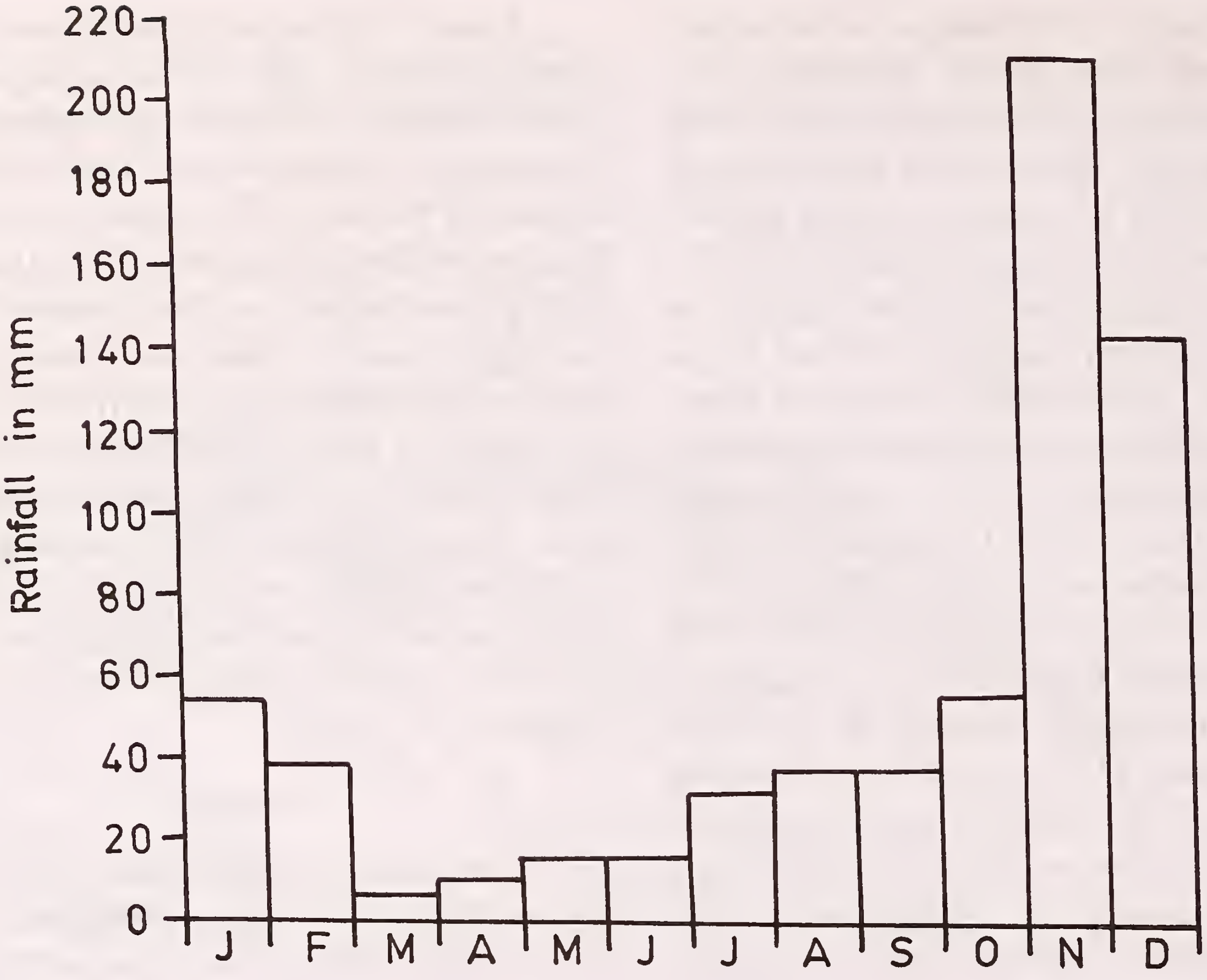

Fig. 2. Average monthly rainfall (1983-'88) at Point Calimere.

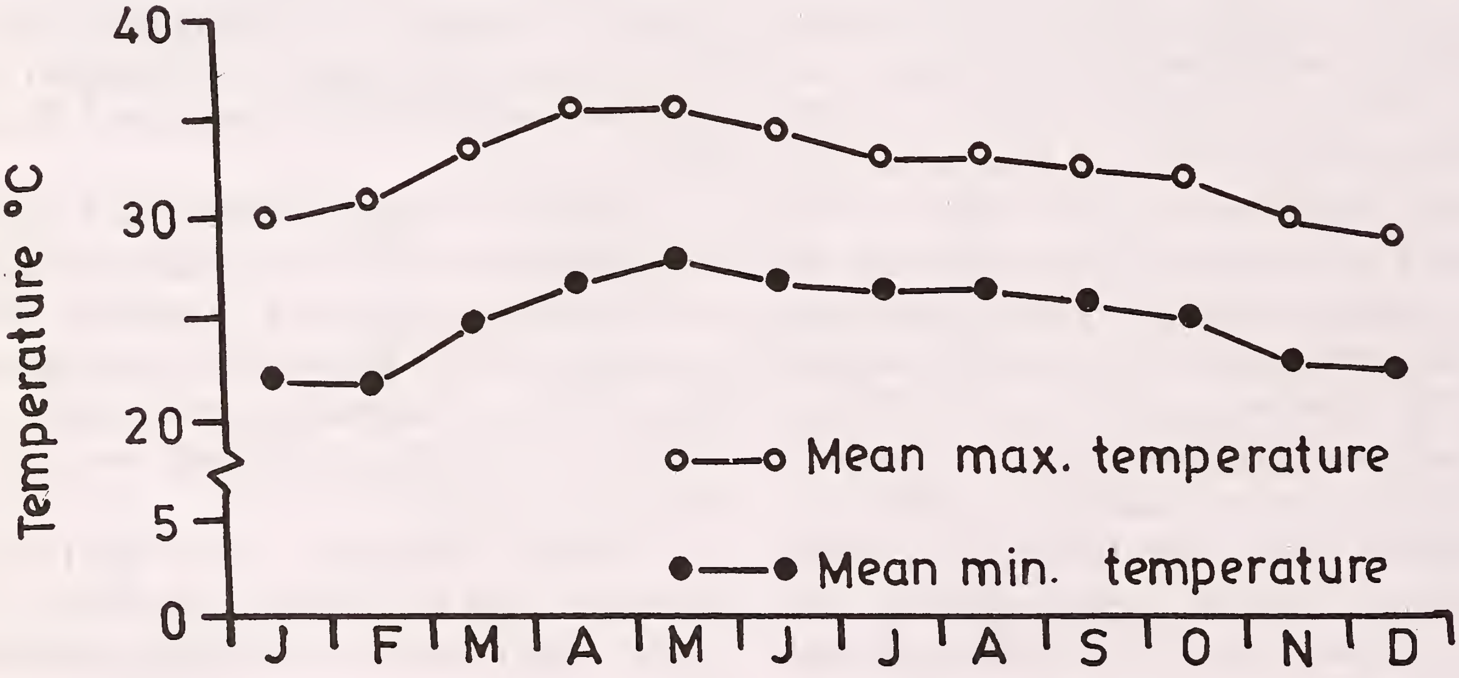

Fig. 3. Mean monthly maximum and mean monthly minimum air temperature (1983-'88) at Point Calimere.

A tree is defined as "any woody perennial which rises from the ground with a trunk"; a minimum height qualification of 3 m is also added. A shrub is defined as a woody non-climbing multiple stemmed or single stemmed perennial plant less than 3 m high. The term climber is arbitrarily used and includes all the plants with non-erect stem and growing on supports.

Brief and extended activity — refer to the duration of fruiting activity by individuals of a plant species or population. 'Brief' fruiting extends for three weeks or less, while 'extended' refers to fruiting for more than three weeks. Fruit maturation periods of three months or less, following fertilization, are termed as 'rapid', while those more than three months as 'lengthy'.

Plants having more than one fruiting sequence annually are referred as 'multiple' fruiting species.

Phenological records: Phenological observations were noted for tagged individuals along a 4 km transect in the sanctuary. Ten individuals of each species were selected. For those species where ten individuals could not be found, fewer numbers were marked — see Appendix 1. Phenological data were collected for 64 plant species — 27 tree species, 23 shrub species and 14 species of climbers. A total of 555 individuals were marked for the study.

The Phenological data on the fruiting were collected once a fortnight from January 1987 to December 1988. The plants were regularly observed and their fruiting status was noted. Three categories, namely 'none', 'few', and 'many' were employed to indicate abundance of fruiting (Frankie *et al.* 1974, Guy *et al.* 1979, Opler *et al.* 1980).

The categories 'none', 'few' and 'many' were assigned values of 0, 1, and 2 respectively. The fortnightly values of fruiting characteristics of all individuals for each species were summed up separately and were divided by the number of individuals of that species. Thereby a 'mean value' was obtained for the fruiting status of each species for each fortnight. Using this technique, the maximum possible value for fruiting for any fortnight is 2.0. This maximum value of 2.0 is considered as 100% and the data for the fruiting activity levels are given in percentages.

Distribution of plants in the study area: The distribution of fleshy-fruited plants in the study area was measured by a belt-transect technique (Skeate 1987). The number of individuals of each species within 20 quadrats measuring 100 x 10 m along a 2 km line transect through the study area was noted. The abundance, density and frequency of each species was calculated after Michael (1986). The frequency was converted into percentage and values thus obtained were placed in five classes, namely class A: rare (1-20%); B: occasional (21-40%); C: frequent (41-60%); D: abundant (61-80%); and E: very abundant (81-100%).

RESULTS

Species composition of fleshy-fruited species: Out of 317 species of flowering plants in Pt. Calimere, 91 species have fleshy fruits. Among these 91 species, 64 species that were eaten or dispersed by birds were selected for the study (Appendix 1). The remaining 27 species were not included in the study because (1) 10 plants were dispersed by mammals; (2) seven species were dispersed by water and (3) the remaining 10 species, though dispersed by birds, either occur rarely in the study area or happened to be annual climbers.

The 64 fleshy-fruited species are distributed in 53 genera belonging to 34 families. Families represented by most native genera with fleshy fruits eaten by birds are Rubiaceae (6), Euphorbiaceae (4) and Cordiaceae (3).

Distribution of fleshy-fruited plants: Since the productivity of fruits of various species could not be compared with the other observations of this study, the frequency distribution of fleshy- fruited plants in the study plot was studied. Out of the 64 fleshy-fruited plants recorded, 20 species were rare; 19 species were occasional; 10 species were frequently seen and the remaining 15 species occurred abundantly.

Fruiting phenology: Fruiting took place throughout the year. However, the number of fleshy-fruited plants in fruits differed during different seasons. The number of species with ripe fruits was lowest during June (summer) in both the years — 1987 and 1988 (Fig. 4). The number of species with fruits started to increase from October (monsoon) in the first year (1987) and in September (late pre-monsoon) in the second year (1988). The peak in fruiting was attained during February (post-monsoon) in the first year, and during March (post-monsoon) in the second year. There was no significant difference in the number of species in fruit between 1987 and 1988 (Wilcoxon's signed rank test, $p>0.10$).

The number of tree species with ripe fruits showed very little month-wise variation in the two years of study (Fig. 4). The lowest number of shrub species with ripe fruits occurred during July (pre-monsoon) in the first year ($n=4$) and during August (pre-monsoon) ($n=3$) in the second year (Fig. 4). Fruiting in shrubs attained its peak in February (post-monsoon) during the first year ($n=14$) and during March (post-monsoon) in the second year ($n=13$) (Fig. 4). Fruiting was absent in climbers during July 1987. Out of the 14 species of climbers only one species was fruiting during June 1988. The number of climber species in fruit attained a peak during March (post-monsoon) in both years. There were no significant differences in the number of species with ripe fruits between 1987 and 1988 (Wilcoxon's signed rank test, $P> 0.10$) in all the three life forms, namely trees, shrubs and climbers.

Multiple fruiting activity: A total of 15 plant species (six trees, eight shrubs and one climber) showed multiple fruiting activity. They are: *Pleurostylia opposita*, *Salvadora persica*, *Ehretia ovalifolia*, three species of *Ficus*, *Carissa spinarum*, *Premna serratifolia*, *Breynia vitis-idaea*, *Olax scandens*, *Dendrophthoe falcata*, *Viscum capitellatum*, *Viscum orientale* and *Salacia chinensis*.

Extended fruiting activity: 11 trees, six shrubs and six climbers had their fruiting extended over a period of a month. Important plants that had extended fruiting were: *Manilkara hexandra, Salvadora persica, Walsura trifolia, Lannea coromandelica, Memecylon umbellatum, Toddalia asiatica, Carmona retusa, Phyllanthus reticulatus, Tinospora cordifolia, Coccinia grandis* and *Solanum trilobatum.*

Lengthy fruit maturation: Eight species had a long fruit maturation period. *Memecylon umbellatum*, *Diospyros ferrea* and *Drypetes sepiaria* among trees, *Capparis rotundifolia, Scutia myrtina* and *Benkara malabarica* among shrubs and *Pachygone ovata* and *Capparis zeylanica* among climbers took long duration (three months) for their fruit maturation.

Fruiting patterns: Based on the observed seasonal fruiting phenologies, the 64 species of fleshy-fruited plants are classified under three seasonal fruiting patterns (Table 1).

Summer and pre-monsoon fruiting: The plants that produced ripe fruits from April to

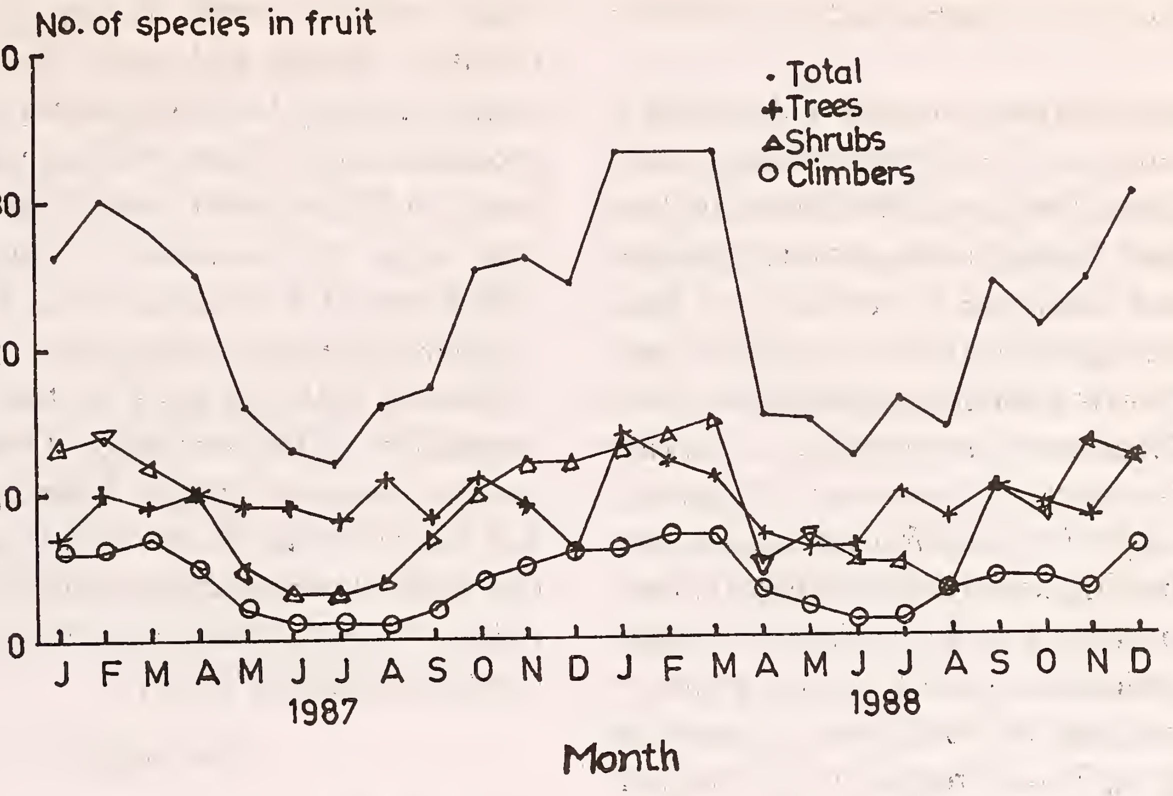

Fig. 4. Number of fleshy-fruited species in fruiting.

August are included in this category. Many of the species fruited mainly between in April and June, but a few started fruiting in March, and some continued fruiting till September. A total of 13 species produced ripe fruits during this period. Three sub-groups are found in this category. Species such as *Ixora pavetta*, *Drypetes sepiaria*, *Cansjera rheedii* and *Cassytha filiformis* had ripe fruits in March and continued to have them till June. Species such as *Walsura trifolia*, *Lannea coromandelica* and *Azadirachta indica* started fruiting in May and continued till September. Species such as *Crateva adansonii*, *Lepisanthes tetraphylla*, *Phoenix pusilla*, *Cordia obliqua* and *Ochna obtusata* had ripe fruits only in summer. *Pachygone ovata* had ripe fruits during pre-monsoon only. The fruiting activity levels of five representative summer and pre-monsoon fruiting species are given in Fig. 5. The summer and pre-monsoon fruiting species in-

TABLE 1

SEASONAL FRUITING PATTERNS OF FLESHY-FRUITED PLANTS AT POINT CALIMERE SANCTUARY

Fruiting pattern	Trees	Shrubs	Climbers	Total
Summer & pre-monsoon	9	2	2	13
Monsoon & post-monsoon	11	15	11	37
All seasons	7	6	1	14
Total	27	23	14	64

(Numerals denote the number of species)
For details refer to Appendix 1.

clude nine trees, two shrubs and two climbers (Table 1).

Monsoon and post-monsoon: A total of 37 species produced ripe fruits during these seasons. Most of the plants that fruited in these seasons started fruiting in September (late pre-monsoon) and continued to produce ripe fruits till March and April (late post-monsoon or early summer). There is a small group of plants which includes *Glycosmis pentaphylla, Syzygium cumini, Canthium dicoccum, Capparis zeylanica, Capparis rotundifolia* and *Scutia myrtina* whose fruiting was strictly confined to monsoon. The fruiting activity levels of 15 representative species that fruited during monsoon, post-monsoon and in both these seasons are given in Figs. 6, 7 and 8 respectively. The monsoon and post-monsoon fruiting species include 11 trees, 15 shrubs and 11 climbers (Table 1).

Year-round fruiting: A total of 14 species had ripe fruits throughout the year with little gaps, i.e. in all the months of a year or at least one month in each season. *Ficus microcarpa, Pleurostylia opposita, Viscum orientale* and *Viscum capitellatum* had ripe fruits in all the months. *Olax scandens, Opuntia dillenii, Salvadora persica, Carissa spinarum, Ehretia ovalifolia, Salacia chinensis* and *Ficus benghalensis* had ripe fruits in all seasons but not in all months. Though species such as *Ficus tsjakela, Plecospermum spinosum* and *Breynia vitis-idaea* fruited in all seasons, their fruiting was at the maximum during monsoon and post-monsoon. The fruiting activity levels of the five representative year-round fruiting species are given in Fig. 9. The year-round fruiting plants include seven trees, six shrubs and one climber (Table 1).

Seedless fruiting by *Salvadora persica*: The tree *Salvadora persica* produced sterile fruits without seeds during the months of February, March and April. During the other months, namely May, September and October, it produced fertile fruits with seeds. The sterile fruit is a thin-skinned berry 5 mm in diameter. The fertile fruit measures 6.2 mm in diameter with a seed of 3.5 mm diameter. It was interesting to note that the seedless fruiting of *S. persica* coincided with the peak in the migrant bird population at the sanctuary. During the other seasons, when migratory birds were absent, it had seeded fruits. However, it is suggested here that further investigations should be made to find out why this plant fails to produce seeded fruits during a particular season.

DISCUSSION

Fleshy-fruitedness among animal-dispersed plants: Hilty (1980) in his review on the fleshy-fruitedness among the plants in various tropical forests mentions that in the tropical seasonal lowland dry forest of Costa Rica, the occurrence of fleshy-fruited species among trees was 51% and among shrubs 58%; at La Selva, a tropical non-seasonal lowland rain forest of Costa Rica 90% were among the trees; in the seasonal Panama forest fleshy-fruited plants were 82% among the combined canopy and understorey trees; at Alto Yunda, a neotropical aseasonal forest, a very high proportion of 89% were fleshy-fruited plants among trees.

The present study revealed that in Pt. Calimere, about 56% among the trees and 56% of shrubs bear fleshy-fruits. Being a tropical dry evergreen coastal forest many of the species at Pt. Calimere bore seeds adapted for dispersal by various means such as by water, wind and self-explosive devices. Hence, the proportion of fleshy-fruitedness among Pt. Calimere plants is lower than in several of the above-mentioned

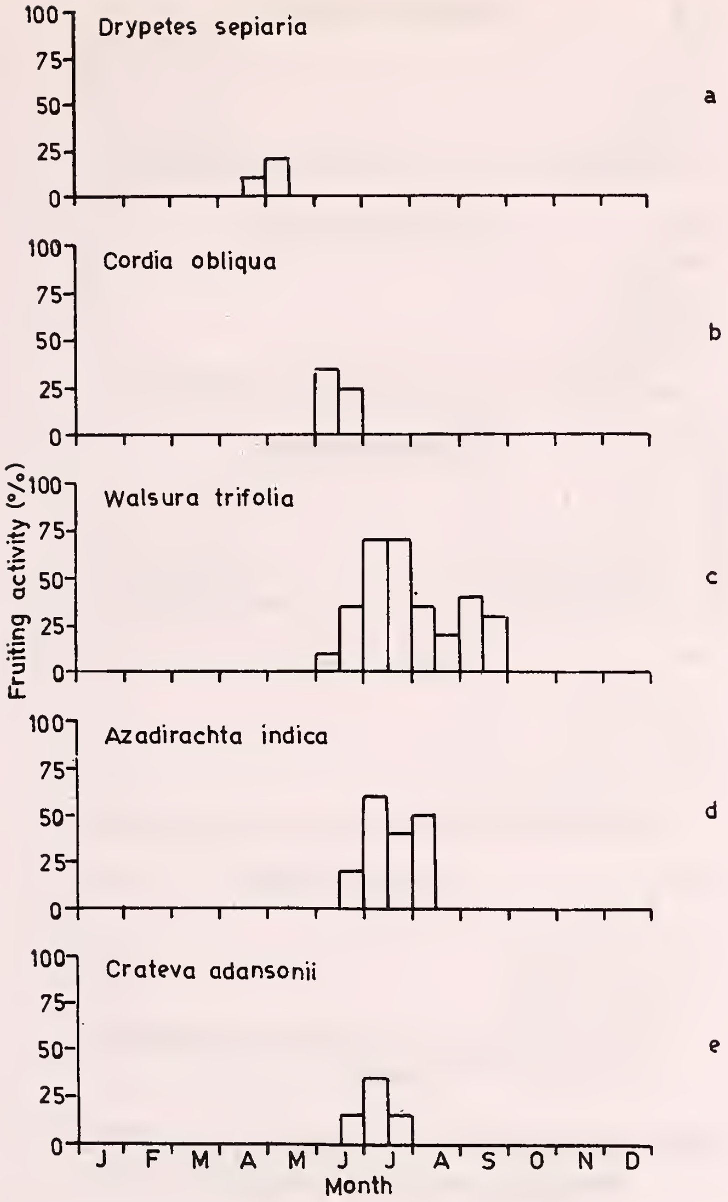

Fig. 5. Fruiting activity levels of five summer and pre-monsoon fruiting plant species during 1988.

areas. However, the Pt. Calimere figures correspond with those of a similar habitat, namely tropical dry lowland forest of Costa Rica.

Fruiting seasonality: Croat (1969), in his phenological studies at Central Panama observed that the number of fleshy-fruited animal-dispersed species that fruited during the dry season was 83, and in the wet season 166.

In the tropical forest in Ghana, Lieberman (1982) observed that though fleshy-fruited species fruited throughout the year, their fruiting peak occurred in the wet season. He further mentioned that a few species that produced fruits continuously, also fruited abundantly under wet conditions.

Howe (1984) stated that all studies of the tropical fruiting phenologies reported seasonality, and that extreme seasonality was certainly found in forests with distinct wet and dry seasons.

Wheelwright (1985), after studying the flowering and fruiting phenology of 23 Lauraceous tree species in the lower montane forests of Monte Verde, Costa Rica, reported that the fruiting seasons were more aggregated and significantly non-uniform.

On the contrary, Frankie *et al.* (1974) in their studies in the dry deciduous forest of Costa Rica observed the fruiting peak of fleshy-fruited plants during the dry season.

At Pt. Calimere, the fruiting phenology showed the presence of a definite seasonality. During summer (dry season) the number of species in ripe fruits was 12 and during post-monsoon (wet season) it was 23. The wet season fruiting peak by fleshy-fruited plants at Point Calimere corresponded with that of many tropical studies (e.g. Croat 1969, Hilty 1980, Lieberman 1982, Wheelwright 1985) and differed from the study of Frankie *et al.* (1974).

CONCLUSIONS

In the Pt. Calimere Wildlife Sanctuary, fruiting takes place throughout the year with a distinct peak during monsoon and post-monsoon and a trough in the late summer and early pre-monsoon. Fruits in most plant species in Pt. Calimere ripen at the peak of avian frugivore migration, namely January to April. This timing helps to allow competition among frugivores for seed dispersal. During summer, only a few resident bird species are available to concentrate on the fruits.

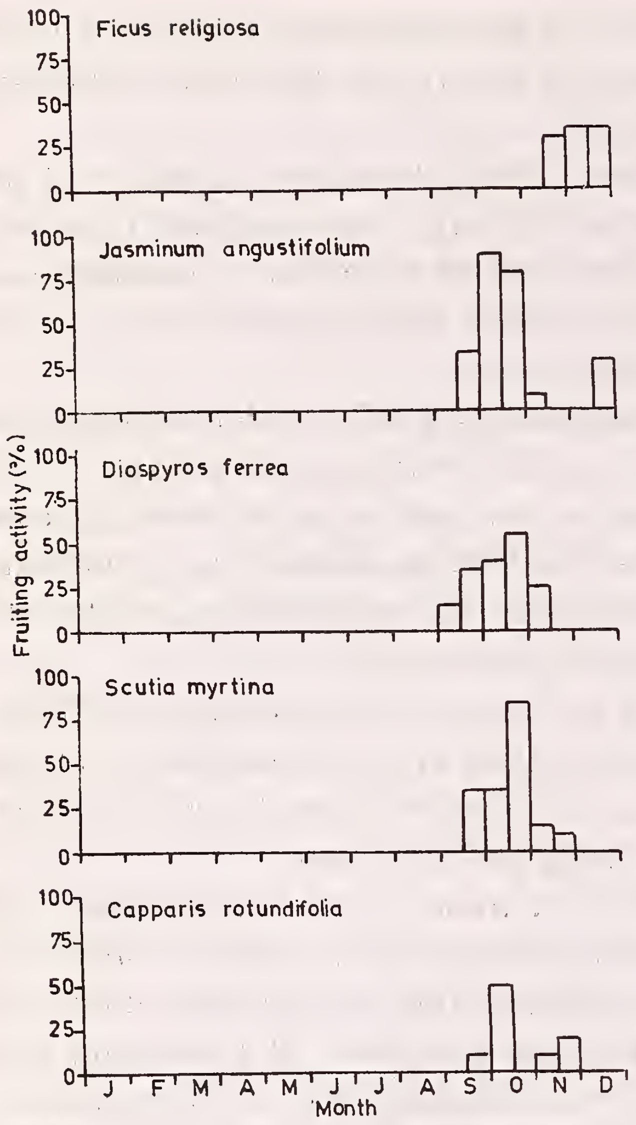

Fig. 6.. Fruiting activity levels of five monsoon fruiting plant species during 1988.

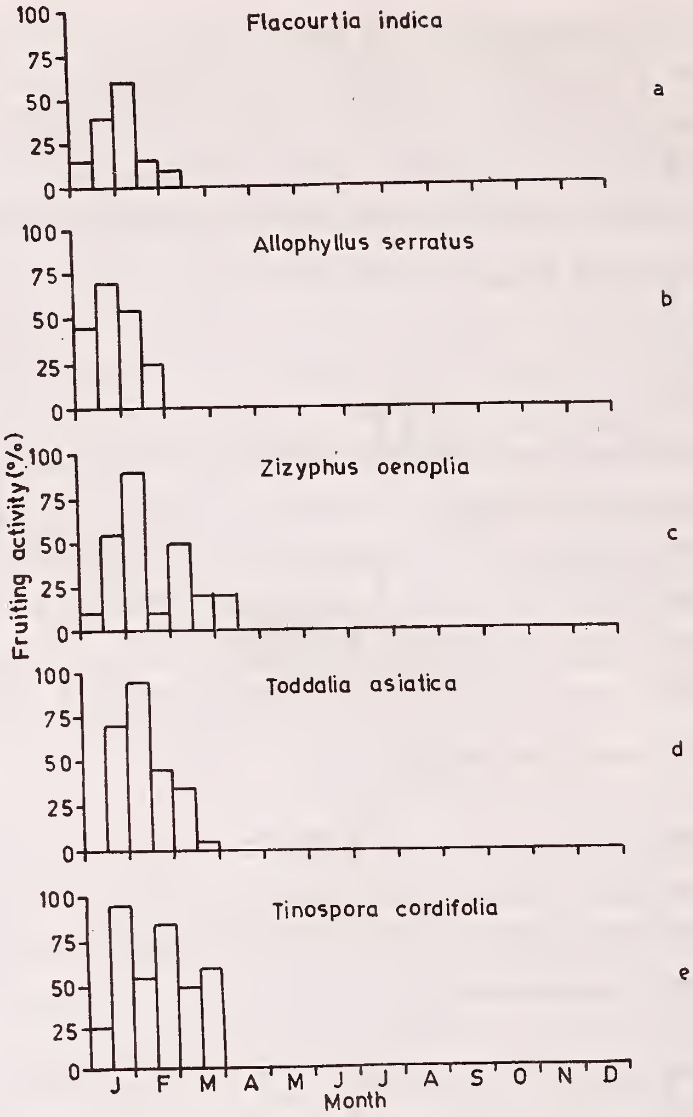

Fig. 7. Fruiting activity levels of five post-monsoon fruiting plant species during 1988..

During late summer and early pre-monsoon, when the ambient temperature is high, several plant species in the sanctuary wither which subsequently leads to a failure in the fruit crop.

During this period, local movements of resident frugivorous birds for food from the sanctuary to the neighbouring villages was noticed. Major frugivorous birds of this sanctuary such as whitebrowed bulbul *Pycnonotus luteolus* and redvented bulbul *Pycnonotus cafer* made local movements. This observation shows that the influence of abiotic factors, especially temperature has more influence on the timing of flowering and fruiting than the biotic interactions.

The study shows that trees such as *Walsura trifolia, Azadirachta indica, Lannea coromandelica, Crateva adansonii* and *Cordia obliqua,* whose fruiting occurs during the extreme dry season, are 'pivotal' species of the community and the elimination of most of these species even for a short period may lead to local disappearance of frugivorous birds.

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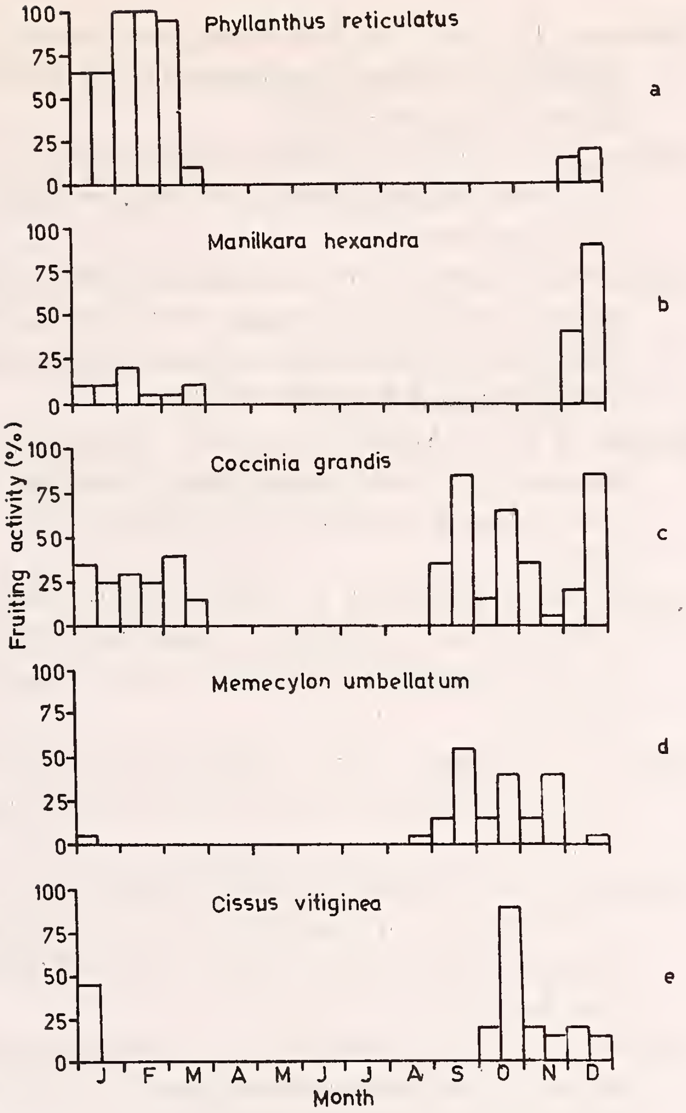

Fig. 8. Fruiting activity levels of five monsoon and post-monsoon fruiting plant species during 1988.

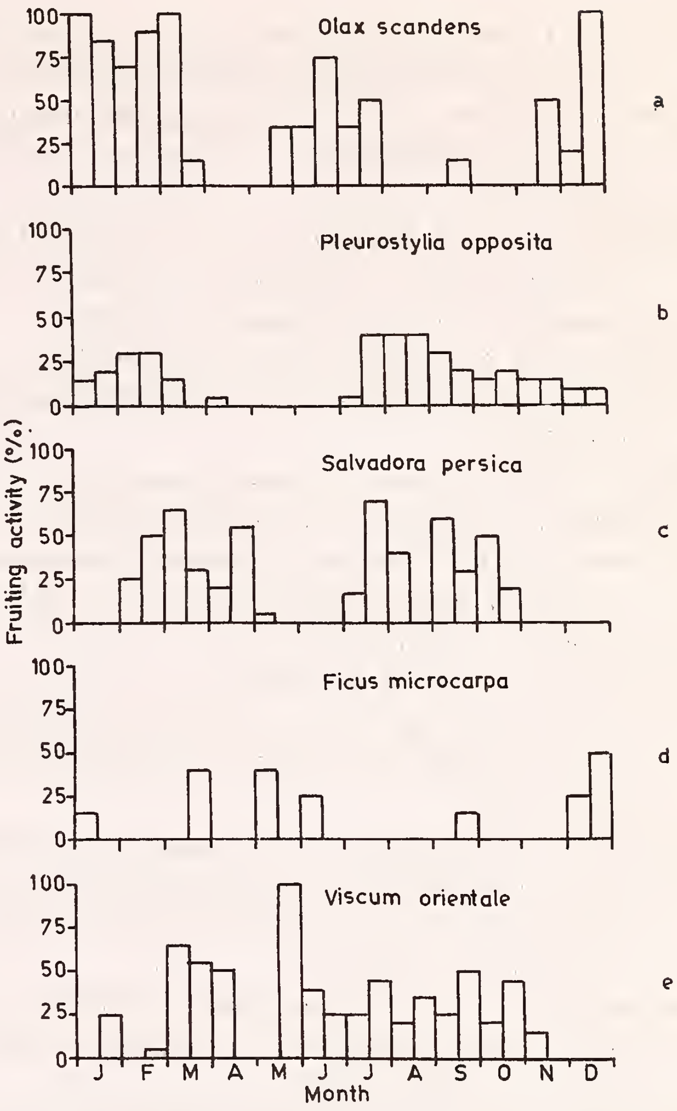

Fig. 9. Fruiting activity levels of five plant species fruiting in all seasons during 1988.

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* Original not referred.

APPENDIX 1

FRUITING SCHEDULE OF FLESHY-FRUITED PLANTS IN PT. CALIMERE SANCTUARY

Family & species	Habit	Fruiting period 1987	Fruiting period 1988	Fruiting pattern
MENISPERACEAE				
Pachygone ovata (Poir.) Miers ex Hook. f. & Thoms.**	c	Aug., Sep.	Aug.	S-P
Tinospora cordifolia (Willd.) Miers ex Hook. f. & Thoms.	c	Dec.-Apr.	Jan.-Mar.	M-P
CAPPARIDACEAE				
Capparis rotundifolia Rottl.	s	Aug.-Nov.	Sep.-Nov.	M-P
Capparis zeylanica L.	c	Sep., Oct.	Jul.	M-P
Crateva adansonii DC.	t	Apr., July-Aug.	Jun.-Jul.	S-P
FLACOURTIACEAE				
Flacourtia indica (Burm.f.) Merr.	t	Nov.	Jan.-Mar.	M-P
LINACEAE				
Hugonia mystax L.	*s*	*July-Dec.*	*Oct.-Jan.*	*M-P*
RUTACEAE				
Glycosmis pentaphylla (Retz.) DC.	s	Oct.-Nov.	Aug.-Sep.	M-P
Toddalia asiatica (L.) Lam.	s	Dec.-Mar.	Jan.-Mar.	M-P
OCHNACEAE				
Ochna obtusata DC.	t	May, June	May	S-P
MELIACEAE				
Azadirachta indica A. Juss.	t	Jun.-Aug.	Jun.-Aug.	S-P
Walsura trifolia (A. Juss.) Harms	t	May, July	Jun.-Sep.	S-P
OLACACEAE				
Olax scandens Roxb.**	s	Jan.-Mar.	Sep., Nov.-Mar., May-July	S-P&M-P
OPILIACEAE				
Cansjera rheedii Gmel.	s	Feb.-Apr.	Mar.-Apr.	S-P
HIPPOCRATEACEAE				
Pleurostylia opposita (Wall.) Alston in Trimen	t	Jan.-May, Aug.-Dec.	Jan.-Apr., Jun.-Dec.	S-P&M-P
Salacia chinensis L.	c	Feb.-Jun.	Apr.-Jun., Aug., Sep., Nov.-Dec.	S-P&M-P
RHAMNACEAE				
Scutia myrtina (Burm.f.) Kurz	s	Oct.-Dec.	Sep.-Nov.	M-P
Zizyphus mauritiana Lam.**	t	Feb.	Dec.-Feb.	M-P
Zizyphus oenoplia (L.) Mill.	t	Jan.-Apr.	Jan.-Apr.	M-P
VITACEAE				
Cissus quadrangularis L.**	c	Jan.-Feb.	Dec.-Feb., Jul.,Aug.	M-P
Cissus vitiginea L.	c	Oct.-Dec.	Oct.-Jan.	M-P

APPENDIX 1 (Contd.)

Family & species	Habit	Fruiting period 1987	Fruiting period 1988	Fruiting pattern
SAPINDACEAE				
Allophyllus serratus (Roxb.) Kurz	s	Dec.- Feb.	Jan.-Feb.	M-P
Lepisanthes tetraphylla (Vahl) Radlk	t	Apr.-May	Apr.	S-P
ANACARDIACEAE				
Lannea coromandelica (Houtt.) Merr.	t	Jun.-Sep.	May-Sep.	S-P
MYRTACEAE				
Syzygium cumini (L.) Skeels	t	Sep.-Nov.	Aug.-Oct.	M-P
MELASTOMATACEAE				
Memecylon umbellatum Burm. f.	t	Oct.-Dec.	Aug.-Jan.	M-P
CUCURBITACEAE				
Coccinia grandis (L.) Voigt	c	Oct.-Apr.	Sep.-Mar.	M-P
Trichosanthes cucumerina L.	c	Dec.-Mar.	Jan.-Mar.	M-P
Trichosanthes tricuspidata Lour.	c	Nov.-Apr.	Dec.-Mar.	M-P
CACTACEAE				
Opuntia dillenii (Ker-Gawl.) Haw.**	s	Dec.-Mar.-May	Mar.-July-Dec.	S-P&M-P
RUBIACEAE				
Benkara malabarica (Lam.) Tirv.	s	Sep.-Mar.	Nov.-Mar.	M-P
Canthium dicoccum (Gaertn.) Teijsm. & Binn.	t	Nov.-Dec.	Oct.	M-P
Canthium parviflorum Lam.	t	Jan.-Feb.	Sep.-Jan.	M-P
Ixora pavetta Andr.	t	Mar.-Apr.	Mar.-Apr.	S-P
Pavetta breviflora DC.	s	Dec., Feb.-Mar.	Feb.-Mar., Oct.-Dec.	M-P
Pavetta indica L.**	s	Jan.-Feb.	Mar.	M-P
SAPOTACEAE				
Manilkara hexandra (Roxb.) Dubard	t	Jan.-May	Dec.-Mar.	M-P
Mimusops elengi L.**	t	Nov.-Apr.	Nov.-Mar.	M-P
EBENACEAE				
Diospyros ferrea (Willd.) Bakh.	t	Oct.-Nov.	Sep.-Nov.	M-P
OLEACEAE				
Jasminum angustifolium (L.) Willd.	c	Oct.-Dec.	Sep.-Dec.	M-P
Jasminum auriculatum Vahl**	c	Mar.	Mar.	M-P
SALVADORACEAE				
Azima tetracantha Lam.	s	May-Nov.	Sep.-Dec.	M-P
Salvadora persica L.	t	Jan.-May Jul.-Oct.	Feb.-May Jul.-Oct.	S-P&M-P
APOCYNACEAE				
Carissa spinarum L.	s	Sep.-May	Jan.-Mar., Sep.-Oct.	S-P&M-P

APPENDIX 1 (Contd.)

Family & species	Habit	Fruiting period 1987	Fruiting period 1988	Fruiting pattern
CORDIACEAE				
Carmona retusa (Vahl) Masamune**	s	Jan.-Feb.	Sep.-Feb.	M-P
Cordia obliqua Willd.	t	May-Jun.	Jun.	S-P
Ehretia ovalifolia Wight	t	Feb., May-Oct., Dec.	Sep.-Nov., Jan.-Feb.	S-P&M-P
SOLANACEAE				
Solanum trilobatum L.	c	Nov.-Apr.	Nov.-Mar.	M-P
VERBENACEAE				
Premna serratifolia L.	s	Nov.-Feb., Apr.	Nov.-Apr.	M-P
LAURACEAE				
Cassytha filiformis L.**	c	Apr.-May	Mar.-May	S-P
LORANTHACEAE				
Dendrophthoe falcata (L.f.) Etting.	s	Jan.-Apr., Oct.	Mar.,Apr.,Sep.-Dec.	M-P
VISCACEAE				
Viscum orientale Willd.	s	Jun.-Dec.	Jan.-Dec., May-Nov.	S-P&M-P
Viscum capitellatum J.E. Smith**	s	Jan.-Dec.	Jan.-Dec.	S-P&M-P
EUPHORBIACEAE				
Breynia vitis-idaea (Burm.f.) Fischer	s	Nov., Feb.-Jun.	May, Nov.-Dec.	S-P&M-P
Drypetes sepiaria (Wight & Arn.) Pax & Hoffm.	t	Mar.-May	Mar.-May	S-P
Phyllanthus reticulatus Poir. in Lam.	s	Nov.-Jan.,	Dec.-Mar.	M-P
	s	Mar.--Apr.		
Securinega leucopyrus (Willd.) Muell.-Arg. in DC.		Oct.	July, Sep.	M-P
MORACEAE				
Ficus benghalensis L.	t	Jan., Mar.-May, Jul.-Aug.	Nov.-Mar., July	S-P&M-P
Ficus microcarpa L.f.**	t	Feb.-Nov.	Dec.-Jan., Mar., May-Jul.	S-P&M-P
Ficus religiosa L. *	t	Oct.-Nov.	Nov.-Dec.	M-P
Ficus tsjakela Rheede ex Burm. f.	t	Apr., Oct.	Jan.-July, Sep.	S-P&M-P
Plecospermum spinosum Trecul**	t	Jun.	Jul., Oct.-Jan.	S-P&M-P
LILIACEAE				
Asparagus racemosus Willd.	c	Mar.-Apr.	Feb.-Apr.	M-P
PALMACEAE				
Phoenix pusilla Gaertn.	s	Apr.	May	S-P

Habit : t = tree; s = shrub; c = climber.
Fruiting pattern : S-P = summer and pre-monsoon;-M-P = monsoon and post-monsoon.
Number of individuals marked for the study: * = 3; ** = 4; rest = 10.

STUDIES ON THE ULTRA STRUCTURES OF ANTENNA OF *CYLAS FORMICARIUS* FAB.[1]

S. DANIEL WESLEY, M. GLADSTONE AND A. MOHAN DANIEL[2]

(*With three plates*)

Key words: *Cylas formicarius*, *Ipomoea batatas*, Ultra-morphology, Sensilla trichoidea, Sensilla chetica, Sensilla basiconica, Sensilla styloconica, Sensilla ampullacea, Sensilla auricillia

The Scanning Electron Microscopic studies on the ultra morphology of the antennal segments of male and female *Cylas formicarius* F., which is a well recognised serious pest of *Ipomoea batatas* Lam., revealed that the distal antennal segments exhibit variation between the sexes. The distribution of sensory structures including sensilla trichoidea, sensilla chetica, sensilla basiconica, sensilla styloconica, sensilla ampullacea, and sensilla auricillia over the antennal segments is also discussed.

INTRODUCTION

Cylas formicarius Fab. is a polyphagous pest, the biology and its host preference has been studied in detail by several workers on a variety of host plants (Henry 1918, Reinhard 1923, Gonzalves 1925, Van Dev Merwe 1926, Cockerham 1943, Trehan and Bagal 1957, Subramaniam 1959). It is a well recognised serious pest of *Ipomoea batatas* Lam. (Convolvulaceae) a versatile crop. The present paper deals with some micromorphological aspects of the antennae, pertaining to the ultramorphology, the structure and distribution of some important sensory structures.

MATERIALS AND METHODS

For the present study live individuals of *C. formicarius* were collected from infested tubers of *I. batatas*, which were kept in a trough covered with a fine muslin cloth. Fresh adults emerging from tubers were collected using a camlin '0' brush and reared *enmass* in separate plastic containers provided with fresh tubers. For electron microscopic studies, the antennae of male and female *C. formicarius* were dissected and the samples were made dust free of particles by cleaning them in absolute alcohol by fine camlin '0' brush under compound dissection microscope. The antennae were fixed using glutaraldehyde and osmium tetroxide both suitably buffered (slightly alkaline 7.1-7.4 pH) before fixation. The samples were fixed on to the stub using a double adhesive tape, then coated with gold for 3 mins., and scanned through GEOL electron microscope, under 5 KV emission current. The vacuum stability was maintained under a pressure of 10^{-4} mm Hg.

RESULT

Studies on the female antennae of *C. formicarius* under scanning Electron Microscope revealed that all segments barring that of the distal segment are similar in shape with a narrow base and armed with pentagonal reticulations (Plate I B,C). Each of these segments bear three pairs of setae situated towards the proximal end directing anteriorly. The length of the setae gradually decreases from proximal towards distal end. The distal segment is comparatively larger and bears four types of sensory structures

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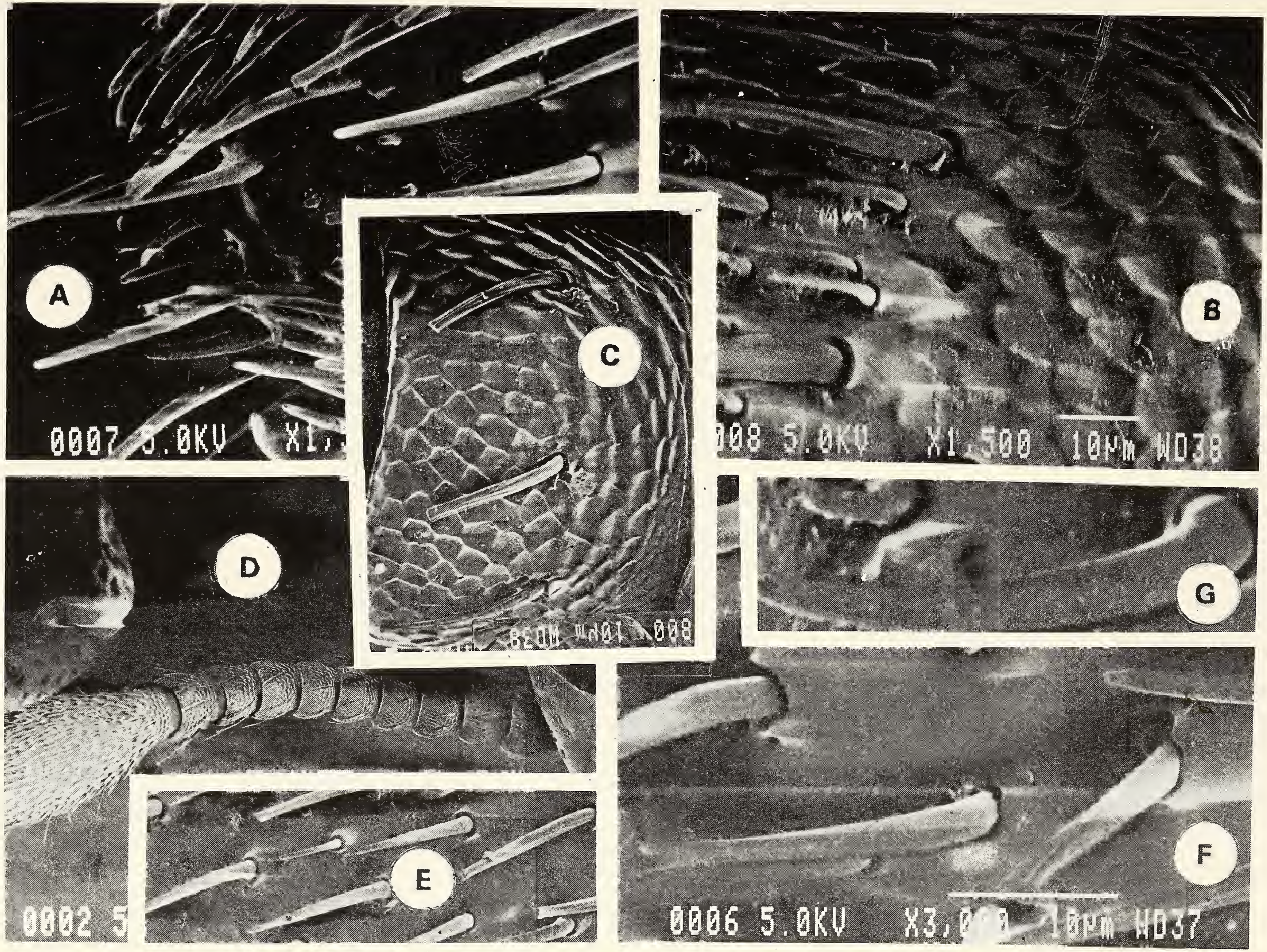
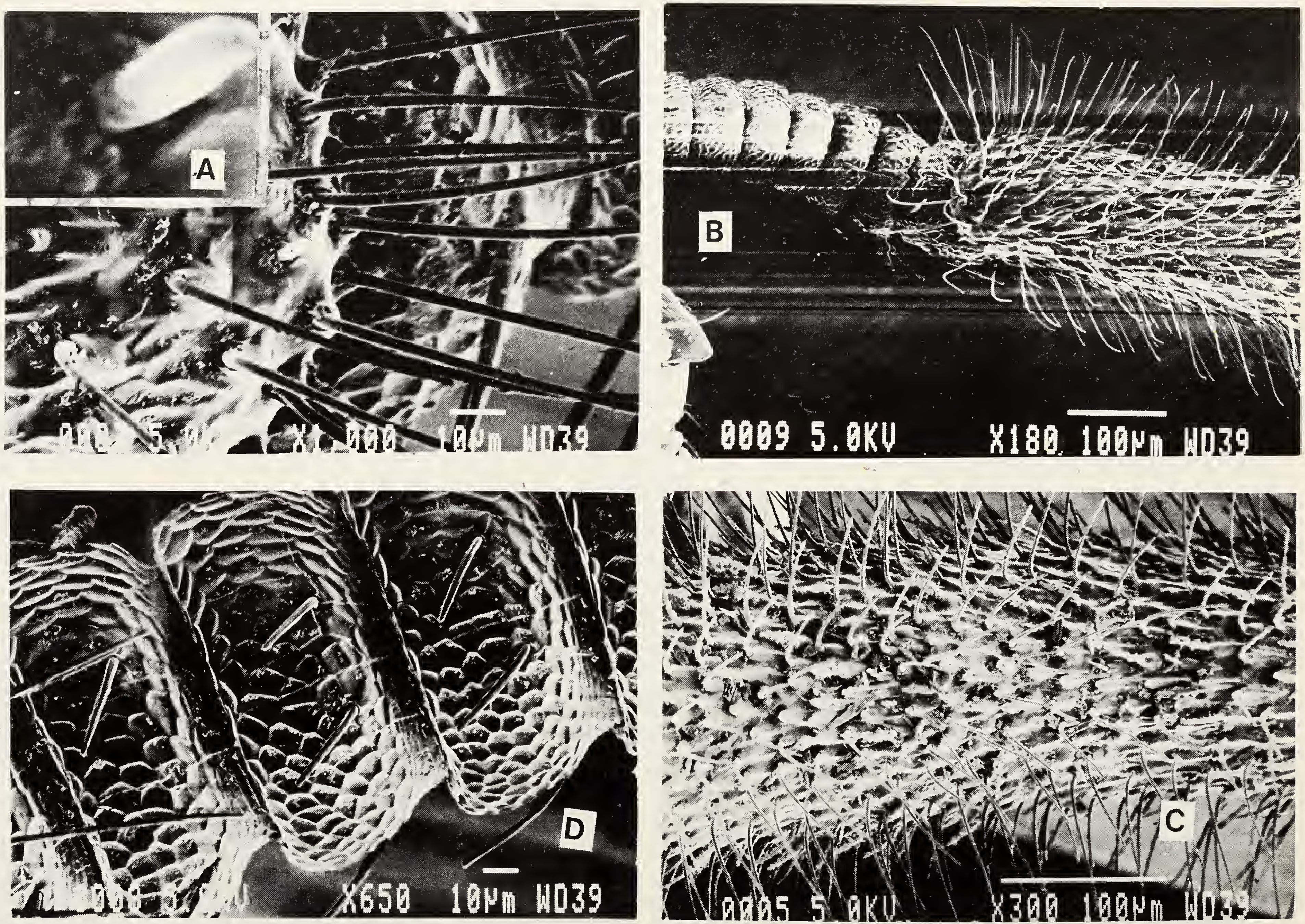
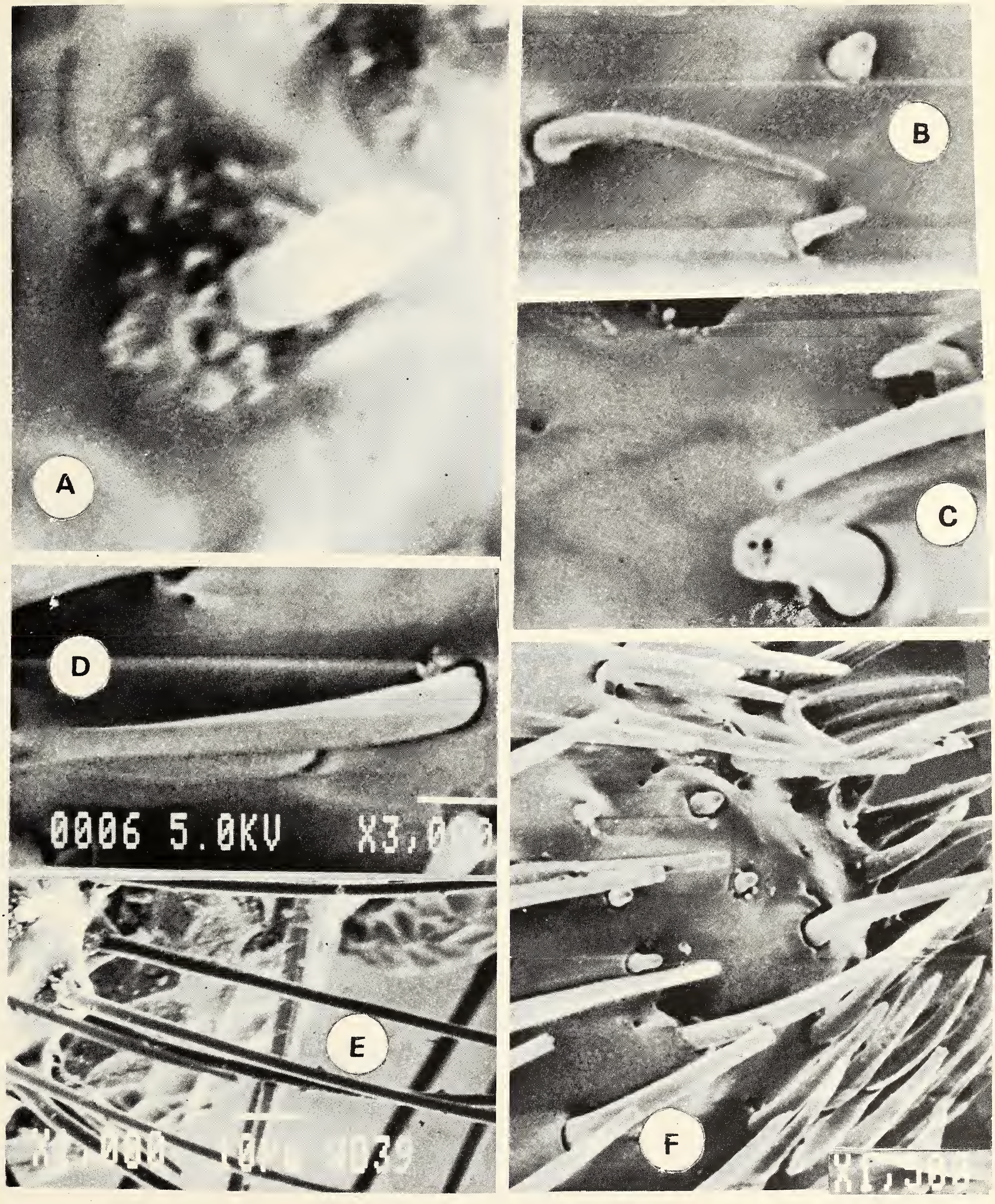

A
0007 5.0KV X1,
B
008 5.0KV X1,500 10μm WD38
C
008 10μm WD38
D
0002 5
E
F
0006 5.0KV X3,0 10μm WD37
G

Scanning Electron Micrographs of female antenna.
A. Distal end of distal segment; B. Proximal end of distal segment; C. Magnified view of the segment of the antennae; D. Female antenna entire; E, F and G. sensory structures at the distal end of the antenna.


A
X1,000 10µm WD39
B
0009 5.0KV X180 100µm WD39
D
X650 10µm WD39
C
0005 5.0KV X300 100µm WD39

Scanning Electron Micrographs of male antenna.
A. The distal segment showing a distinct sensory structure, sensilla auricillia. Insert enlarged view of sensilla auricillia;
B. Male antenna entire; C. distal segment of the antenna; D. Homologous segments of the antennae.



A. Sensilla auricillia; B. and D. Sensilla chaetica and sensilla basiconica; C. Sensilla chaetica; E. An enlarged view of the base of the distal segment of male showing sensory structures; F. The apex of the distal segment of female showing the distribution of sensory structures like sensilla styloconica and sensilla ampullacea.

varying in shape and structure. Unlike the other segments, only the base of the distal segment is provided with pentagonal armature and are absent at the distal end, where the sensory structures are present.

The various types of sensory structures are (i) sensilla chaetica (Plate III D) (Plate I G) which is characterised by an external spine-like process with a distinct cuticular membrane, (ii) sensilla basiconica (Plate III B) where the sensory processes are modified into freely exposed pegs or cones, (iii) sensilla styloconica (Plate I A) (Plate III F) which appears similar to that of sensilla basiconica are situated at the distal ends, while sensilla ampullacea (Plate III F) which appear as pits are distributed randomly on the distal segment.

The antenna of the male also consists of ten segments, in which nine segments are homologous annulated segments, whereas the tenth distal segment is club-shaped and vary in size among the two sexes. The other homologous segments are similar in configuration as that of female antennal segments but are comparatively smaller in size. As in the female the distal segment is also provided with sensory structures but their number is comparatively more than that of the females. The densely distributed setae present on the tenth antennal segment are much slender and longer than those of females. There is not much variation among the sensory structures on distal segment as in the females. The sensory structures present on the distal segments of males include sensilla trichoidea, (Plate II C) which is characterised by the presence of typical hairs without a basal cuticular ring, and the only structure which differs from this is sensillia auricillia (Plate II D) (Plate III A) located at the ventral base of the distal segment.

Discussion

Scanning Electron Microscopic studies on the distal antennal segment of female of *C. formicarius* revealed the presence of four types of sensory structures. They are sensilla chaetica, sensilla basiconica, sensilla styloconica and sensilla ampullacea. Sensilla chaetica is an example of classical contact chaemoreceptive sensilla and it occurs in large number of the distal antennal segment of the female. This was also found in *Rhaphidopalpa foevicollis* (Lucas) in which, the bristiles with blunt tips as well as with pointed ends serves as mechano receptors (Raman and Annadurai 1985). Structures similar to sensilla basiconica of *C. formicarius* were also reported from *R. foevicollis* in which it functions as an olfactory sensilla (Raman and Annadurai 1985). Boechkh *et al.* (1965) explained that sensilla basiconica contains odour specialist and odour generalist neurons, where the former neurons of similar sensillum in one individual, but have partly overlapping pattern in reacting cells. Electron Microscopic studies on sensory structures related to feeding in specialised Lygaeids, namely *Oxycarinus hyalipennis* Costa, *Spilostethus hospus* (Fab.), *Nysius ceylonicus* Motsch, and *Elasmolomus sordidus* (Fab.) revealed the presence of sensilla basiconica and sensilla trichoidea at the tip of the proboscis and such structures were not uncommon on the antennae of insects (Ananthakrishnan 1986).

Sensilla styloconica which appears in the form of pegs and cones at the distal edges of tenth antennal segment are present in *C. formicarius*. This is also supported by the observations made by Blom (1978) on the oligophagous *Pieris brassicae* Linn. (Lepidoptera) and he correlated with behavioural responses in terms of feeding to the sensory response to sinigrin, strychine and proline positively. Ablation of styloconicum sensilla in *P. brassicae* profoundly affected its behavioural responses, but however in the polyphagous species *Mamestra brassicae* (Linn.) the complete removal of styloconicum sensilla does not affect its behavioural response in terms of feeding. This substantiates the fact that the different species possess different types of gustatory cells and the response of spectra being adopted to perception of chemical compounds, present in host plant, by insect species (Visser 1983).

There are two types of sensilla, sensilla trichoidea and sensilla auricillia are present on the distal antennal segment of male. The sensilla trichoidea of trichoid sensilla present on the tarsi and mouth parts of many insects are mainly chaemoreceptory in function and it can also be function as mechano receptor (Ananthakrishnan 1986). These sensilla are stimulated by chemical substances present in the host plants. Sensilla trichoidea and sensilla auricillia are distributed on the various parts of the insect body and are abundant on the antennae, mouth parts and legs. The present study revealed the presence of such structures in abundance on the distal antennal segment of *C. formicarius.* Extripation studies can highlight the positive role played by both these sensilla in initiation of feeding in insects (Ananthakrishnan 1986). This may be the reason for probing the host surface by *C. formicarius* before feeding. Numerous multifunctional trichoid sensillae are found on the male antenna of *C. formicarius.* Since it can function as chaemoreceptor as well as mechanoreceptor the other types of sensory structures observed on the antennae of female *C. formicarius* appears to be absent.

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HABITAT PREFERENCE OF FISHES IN WETLANDS IN RELATION TO AQUATIC VEGETATION AND WATER CHEMISTRY[1]

C. R. AJITH KUMAR AND D.D. MITTAL[2]

(*With seven text-figures*)

Key words: Aquatic vegetation, *Channa* sp., *Cirrhinus* sp., *Heteropneustes* sp., habitat, *Notopterus* sp., water chemistry, Wetland fishes.

The study was conducted over a period of three years in the monsoonal wetland of Keoladeo National Park, Bharatpur, Rajasthan, a famous waterfowl reserve in the subcontinent. Fish were sampled from various habitats using passive methods. The air-breathing fishes such as *Channa punctatus*, *C. striatus*, *Heteropneustes fossilis* and *Clarias batrachus* were recorded from various types of habitats. However, *Channa punctatus* was more widely distributed, evidenced by the frequent occurrence even in thick *Paspalum distichum* dominated habitat. Non-air-breathers frequented open water or sparsely vegetated habitat. The highest species richness of fishes was in sparsely vegetated habitat and the lowest in thick *Paspalum distichum* dominated habitat.

For a better understanding of the role of water chemistry on species distribution, sampling stations were pooled into two major macrohabitats, namely (i) with sparse vegetation and (ii) with thick vegetation. The water temperature and pH hardly differed between these two macrohabitats while DO, total CO_2 and methyl orange alkalinity differed considerably. While DO was higher in open water, total CO_2 was more in thick vegetation. It seems that these factors may be the limiting physico-chemical factors of the distribution of fish in the wetland. The dominance of air-breathers is because of their ability to breath the air directly in oxygen depleted environment. The size of the species is equally important because the small species can move easily in the thick vegetation. The frequency of *C. punctatus* in the thick vegetation may be due to their small size. Non-air-breathers avoided thick vegetation because of the low DO and other air-breathers avoided this habitat due to their comparatively large body size which hinders their easy movement.

INTRODUCTION

The present study was conducted in the monsoonal wetland of Keoladeo National Park, Bharatpur, Rajasthan, a renowned waterfowl reserve also famous for many colonial breeding fish-eating birds.

In earlier habitat related studies of fish, Larson (1980) discussed the habitat selection of rock fishes in California and Schlosser (1982) described habitat selection and depth distribution resulting from predation risk in stream fishes. Tailor (1988) reported macro habitat shifts in salmon. Such studies, however, have not been attempted in fresh water wetlands, the transitional area between aquatic and terrestrial habitats. The ecological aspects of fishes in Northern Prairie wetland were discussed by Peterk (1989) and those of Everglade wetland by Kushlan (1974, 1976a, b). Other related studies were by Frayer (1959), Gladfelter and Gladfelter (1975), Ebersole (1977), Larson (1980), Waldner and

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Robertson (1980), Winter and Ross (1981), Fraser and Cerri (1982), Werner *et al.* (1983), Livingston (1984) and Van Den Avyle and Petering (1988). These studies largely emphasised the fish community rather than habitat preference.

METHODOLOGY

Aquatic habitats were classified into various microhabitats following Lawrence (1955) with slight modifications to be in tune with the purpose of this study. Five major habitats thus distinguished were:

1. **Without vegetation:** Water stretches devoid of any vegetation present in the middle of certain blocks and the deeper area near the dykes. Under this group only one microhabitat was differentiated, i.e. the open water (Ow).

2. **Sparse vegetation:** This type is further distinguished into three microhabitats, namely (1) floating vegetation (Fl) consisting of areas with floating plants such as *Azolla pinnata*, *Spirodela polyriza*, *Lemna posicostata* and *Wolffia* sp., (2) submerged vegetation (Sub) formed of *Hydrilla verticillata*, *Valisnaria spiralis*, *Najas minor*, *Potamogeton*, *Scirpus* and their combinations and (3) floating + submerged vegetation (Fl + Sub). The habitat formed of floating and submerged plants are grouped in this type.

3. ***Ipomoea* and its combinations:** *Ipomoea aquatica* an amphibious plant as the area gets inundated continues to grow and float on the surface. Along with other species, it forms various microhabitats such as (1) *I. aquatica* alone (Ipo), (2) *I. aquatica* + floating vegetation (Ipo + Fl) and (3) *I. aquatica* + submerged vegetation (Ipo + Sub).

4. *Paspalum distichum* **and its combinations:** *P. distichum* is the most problematic grass inside the Park. This amphibious grass spread into the aquatic area forming a mat, ever since the ban on grazing in the Park. Most of the shallow area of the wetland was heavily infested with this plant inhibiting the growth of other species. This major habitat is divided into: 1) *P. distichum* strands (Pas), 2) *P. distichum* + *I. aquatica* (Pas + Ipo), 3) *P. distichum* + *I. aquatica* + submerged vegetation (Pas + Ipo + Sub) and 4) *P. distichum* + *I. aquatica* + floating vegetation (Pas + Ipo + Fl).

5. **Muddy pool:** The deeper areas in the wetland which forms slushy pools in peak of summer. The fishes congregate during the dry season in these pools.

The biological year in the Park is divided into two seasons (Tonn and Mangnuson 1982). 1) The flooding and flooded period (Autumn and Winter — hereafter referred as winter) and 2) The drying period (hereafter referred to in the text as summer). The former (i. e. winter), follows the water release into the Park which may occur in July, August or September, depending on rainfall in the region. Winter extends up to March. During winter most areas of the wetland are inundated. The summer starts with season, the drying up period from April and extends up to the onset of monsoon and the release of water to the wetland.

Fish sampling methods: Fishes were sampled from each habitat using passive methods. Gill net of the size 11 x 1.2 m with mesh size ranging from 3.5 to 6.6 cm were used to sample in open water and sparse vegetation habitats. Traps of the size 35 x 30 x 40 cm made of split bamboo were employed to sample in habitats with thick vegetation. Eight traps along with 4 fences were used at a time (Kumar 1991 and the sampling effort was uniformly maintained. Sampling was continued for three years (1984-85, 1985-86 and 1986-87). However, detailed analysis was attempted only for 1985-86.

Chemical properties of water: Samples were collected from 20 sampling stations in the Park in six aquatic blocks, canal and Mansarovar which is the deepest point in the Park (Ali and Vijayan 1983). The samples were pooled so that half of the stations were in thick vegetation and the other half in sparsely vegetated areas and open water (hereafter referred in text as macrohabitat: 1. vegetation and 2. open water). Every fortnight, samples were collected from each station and the monthly averages were computed. The following physico-chemical parameters were estimated using standard methods (APHA/AWWA/WPCF 1985, Welch 1948): a) Water depth at the sampling sites, b) Water temperature during the sampling time (6 to 9 a.m.), c) pH, d) DO (dissolved oxygen), e) total dissolved CO_2, f) Alkalinity.

RESULTS AND DISCUSSION

Physico-chemical properties of water: Water depth varied from year to year due to the variation in the quantum of water released into the Park. However, average depth in the two macrohabitats the pooled habitats hardly showed any difference (Fig. 1). The gradual decrease of water was mainly due to the evapo-transpiration and infiltration (Azeez 1991). Water temperature gradually decreased and the minimum was recorded during January, thereafter it increased. Little variation was recorded between macrohabitats (Fig. 2).

pH did not differ notably between the two macrohabitats. It was lower in thick vegetation than in open water (Fig. 3). Dissolved oxygen differed strikingly between the macrohabitats (Fig. 4). DO value was more in areas with less vegetation than in thick vegetation. The depletion of oxygen may be because of the decomposition of macrophytes which was dominant in that area. The peak in DO was during January (in open water areas). During this time the decomposition rate will be less due to the lower tmperature and the solubility of oxygen in the water will be high. The lowest value was recorded during May (in thick vegetation). In summer the decomposition rate will be high which resulted in the lowest DO value. Total dissolved CO_2 in water is often inversely proportional to DO. Striking difference in CO_2 between the two macrohabitats were noticed. It is invariably higher in thick vegetation and low in areas having less vegetation (Fig. 5). The lowest CO_2 content was recorded in January (in open water) and highest in July (in thick vegetation).

Phenolphthalein alkalinity varied between the habitats (Fig. 6) but the variation was not in a specific pattern. However, methyl orange alkalinity (MOA) was notably low in open water than in thick vegetation. A gradual increase of MOA was noticed in both habitats till June. It declined thereafter (Fig. 7). MOA was mainly due to bicarbonates in the water. The increase in MOA may be due to gradual reduction in the primary productivity and increase in number of consumer organisms.

Habitat preference of fish: The fish catch composition was differed in different habitats. The preferred habitats in the decreasing order of fish species richness were as follows: floating + submerged vegetation, submerged vegetation, open water, floating vegetation, *Paspalum* + *Ipomoea* + submerged vegetation, *Ipomoea* + submerged vegetation, *Ipomoea* + floating vegetation etc. (Table 1). The macro habitat, open water with sparse vegetation (4.89) was the highest preferred habitat (4.89) and the least preferred was *Raspalum* dominated area (0.768).

The non-air-breathing fishes preferred less vegetated habitats, whereas the air-breathers

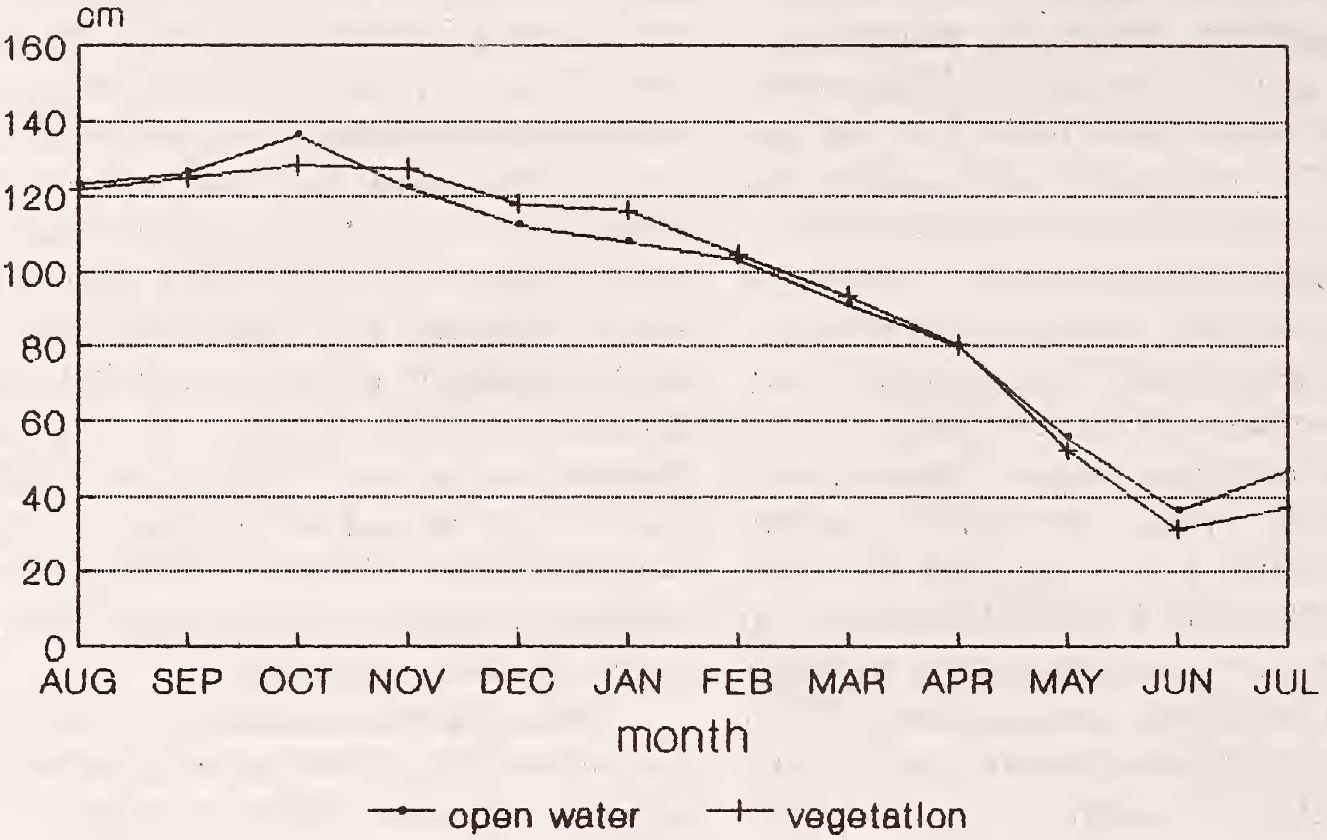

Fig. 1. Average water depth in two macrohabitats during 1985-86.

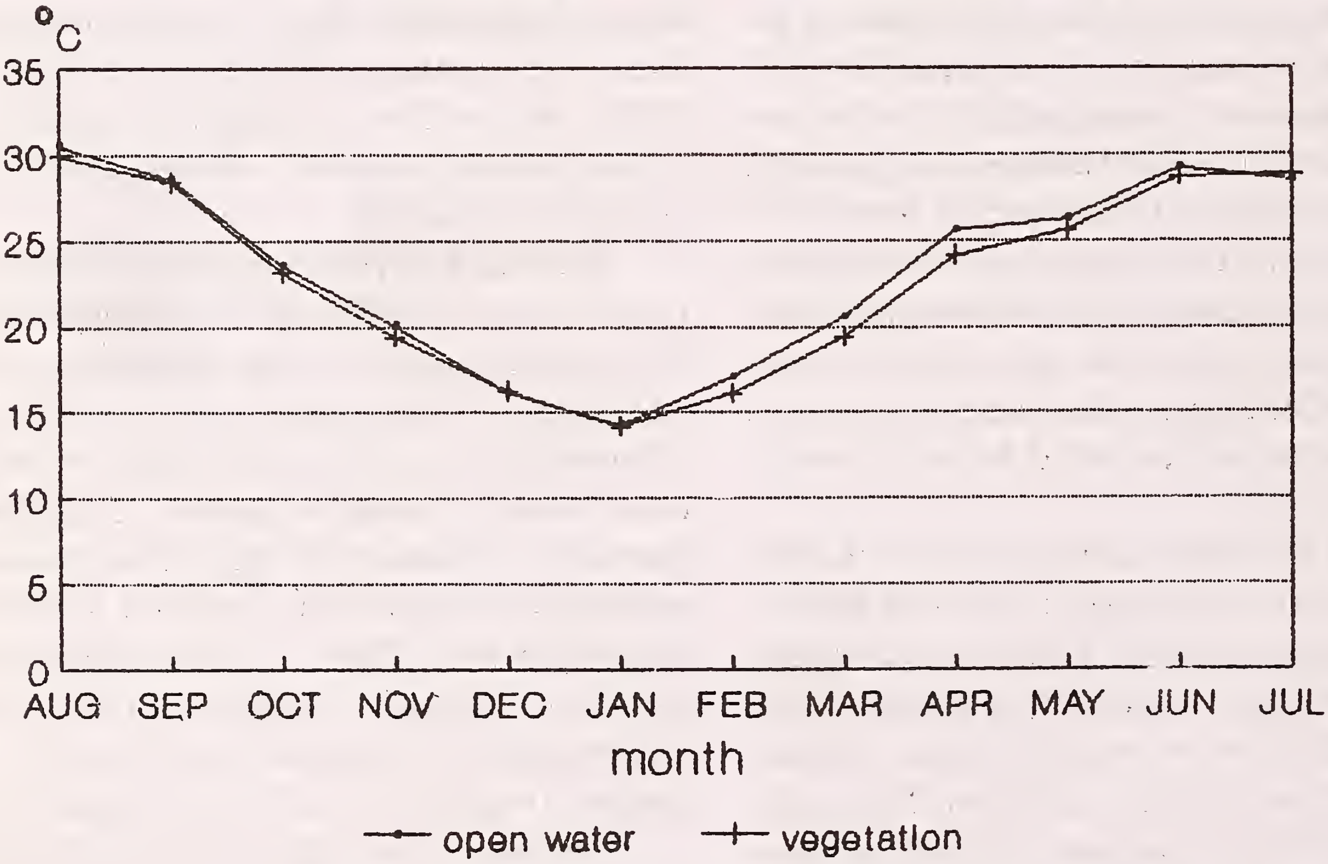

Fig. 2. Average water temperature in two macrohabitats during 1985-86.

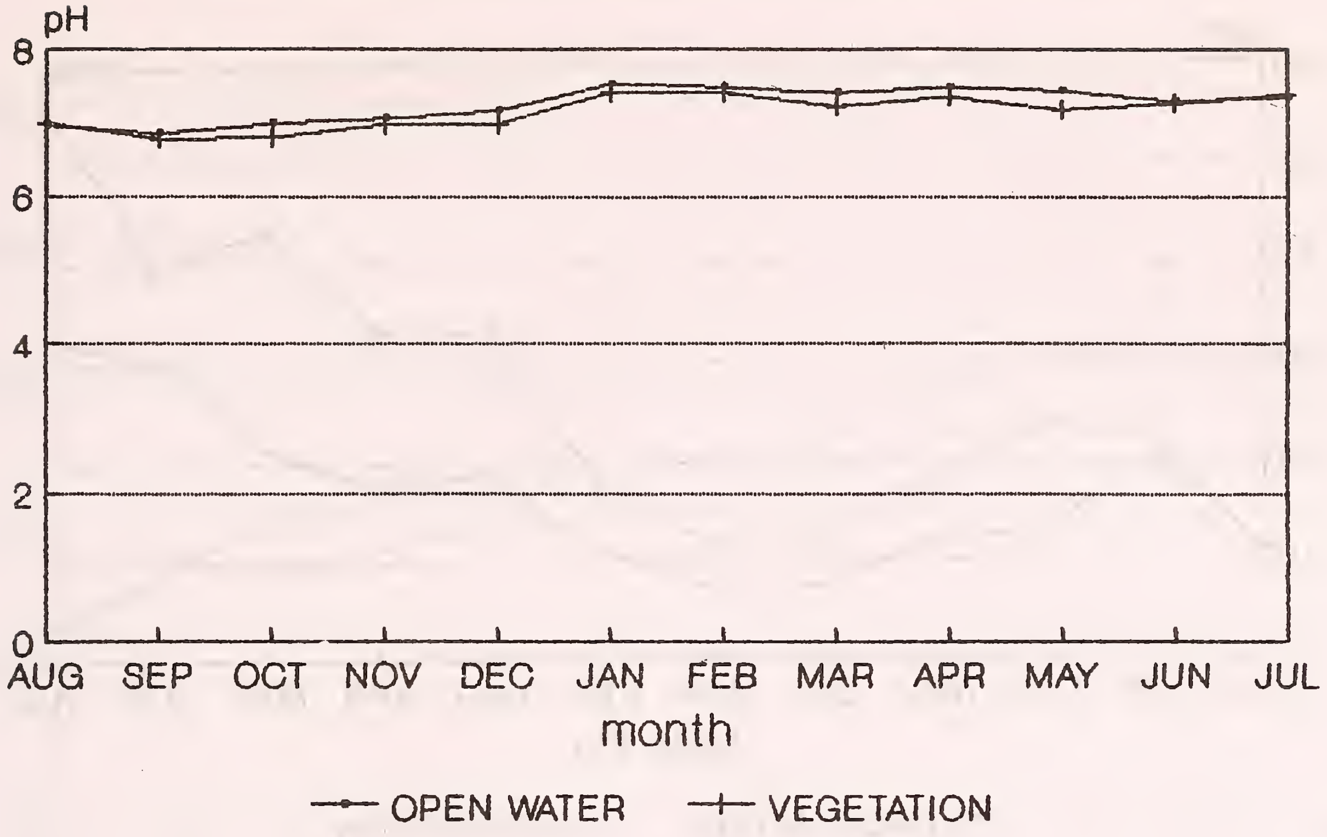

Fig. 3. Average pH in two macrohabitats during 1985-86.

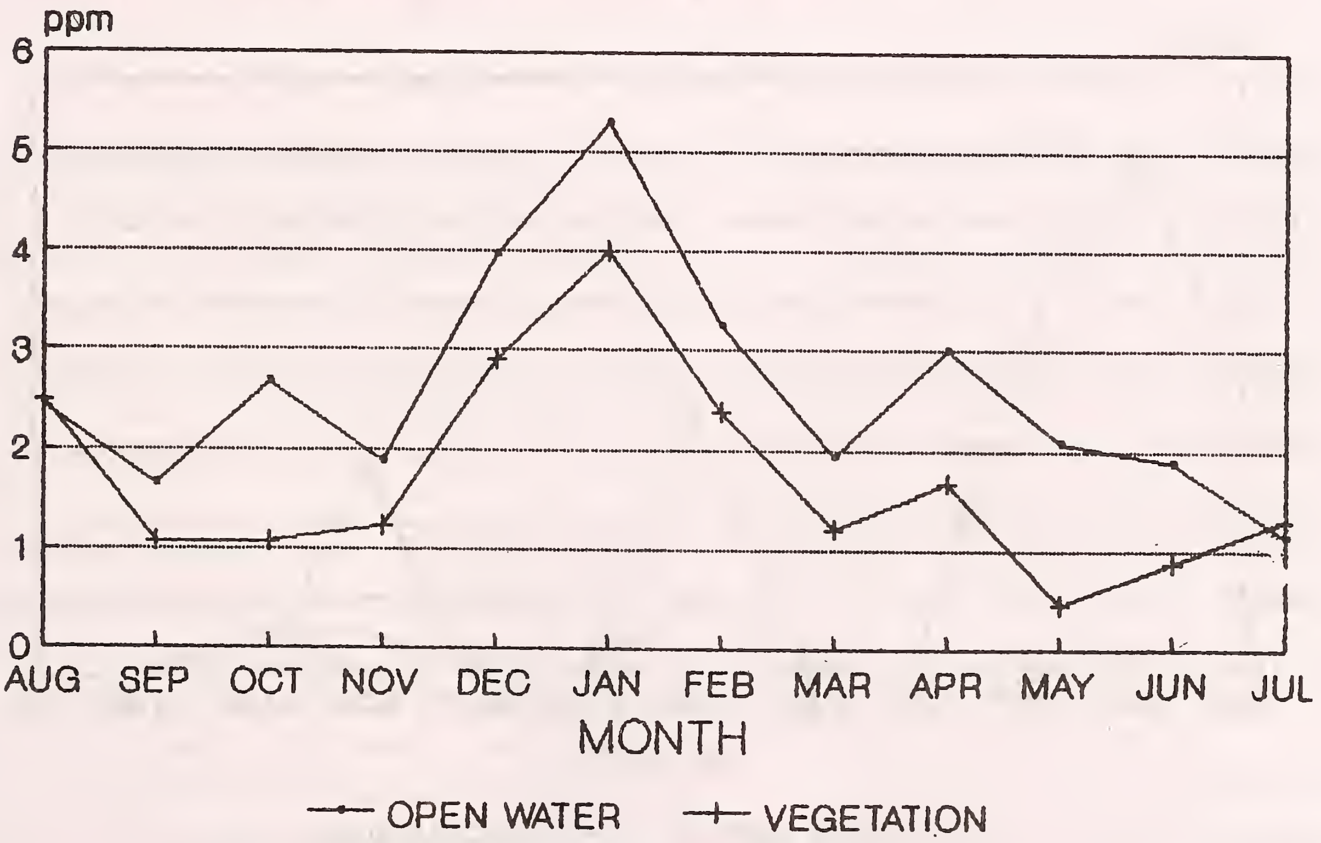

Fig. 4. Average DO in two macrohabitats during 1985-86.

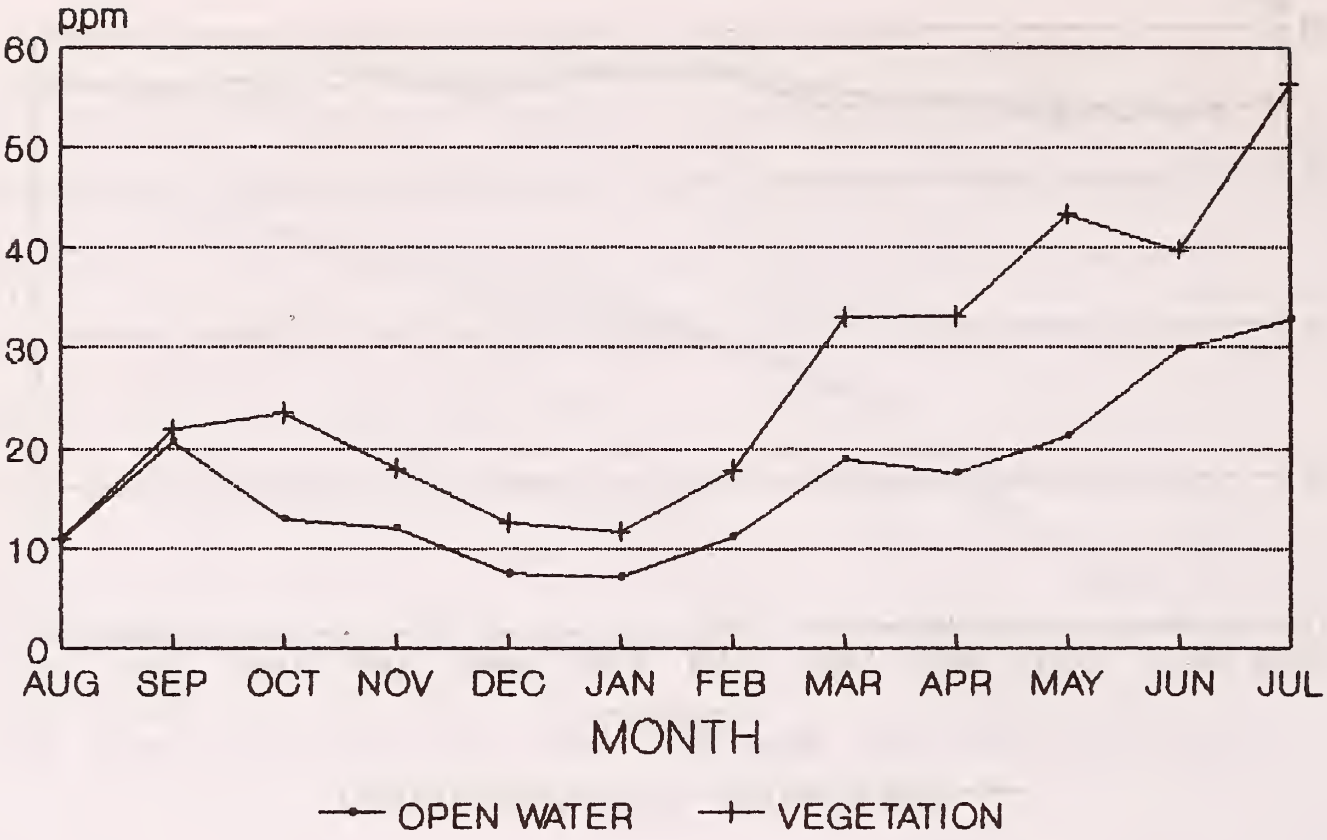

Fig. 5. Average CO_2 in macrohabitats during 1985-86.

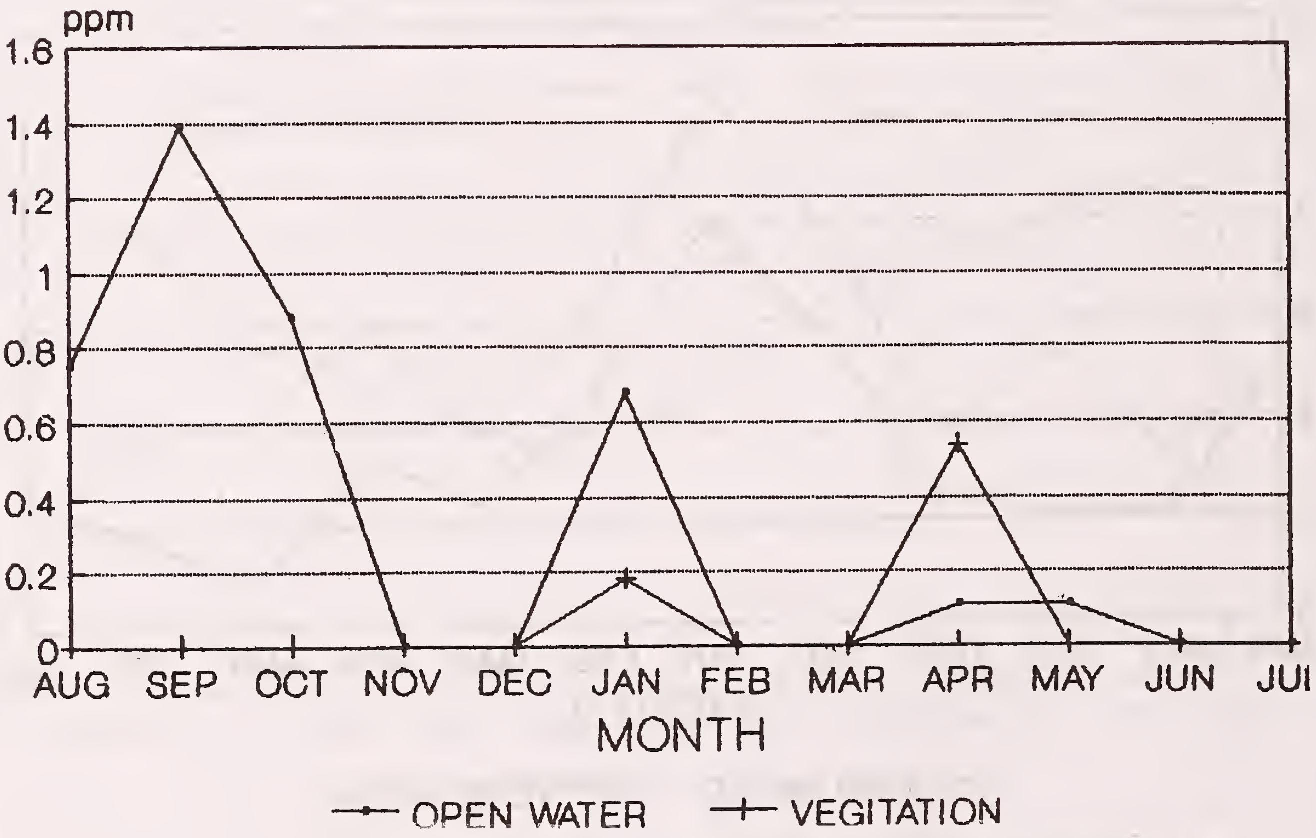

Fig. 6. Average phenolpthalein alkalinity in two macrohabitats 1985-86.

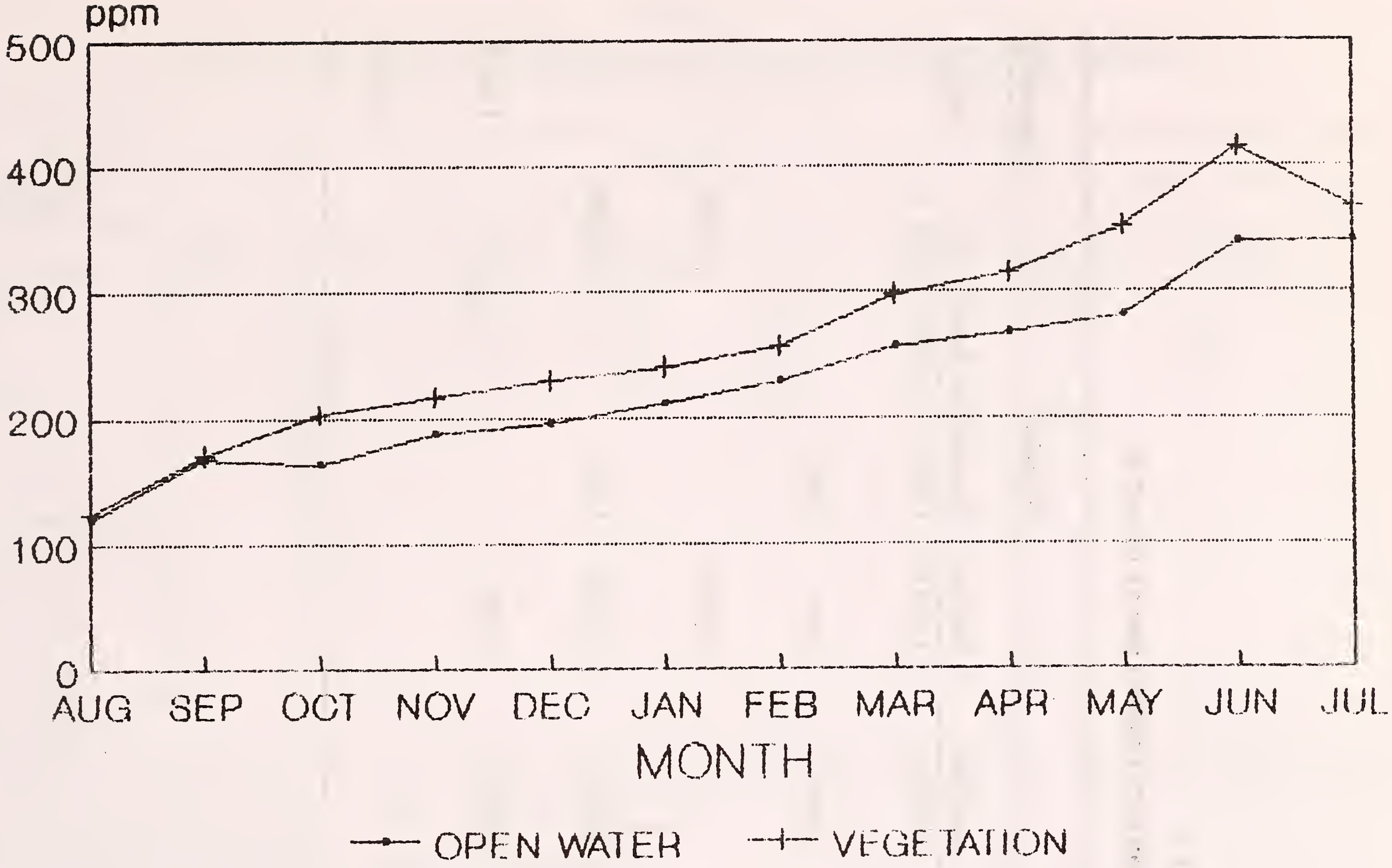

Fig. 7. Average methyl orange alkalinity in two macrohabitats (85-86).

(e.g. *C. punctatus*) were seen in widely differing types of habitats including even the *Paspalum* dominated areas. Thick vegetation inhibit the free movement of fish. It also leads to depletion of DO due to the decomposition of plant material. The non-air-breathers avoid thick vegetation basically because of the low oxygen tension.

Channa punctatus was one of the numerically dominant species among the air-breathers, having a wide habitat preference ranging from open water to thick *P. distichum* mat. The air- breathing nature of the fish helps them to tide over a situation where oxygen is depleted or is at a low level. In addition, the small size of species helps in its movement through the thick grass. *C. striatus* a medium sized fish among the different species in genus *Channa*, shows more or less, the same preference and pattern of habitat utilization as *C. punctatus* (Table 2).

Another important air-breather *Heteropneustes fossilis* was recorded from different habitats of the wetland. In winter, it was recorded mostly in floating vegetation, open water and floating + submerged vegetation. *Clarias batrachus*, an air-breather morphologically similar to *H. fossilis* was collected mostly from the habitats having floating vegetation (Table 2). However, the population of this species is very small in the Park, hence they were not seen frequently in all collections.

Compared to the air-breathers, the non-air-breathers preferred a limited number of habitats, open water and sparse vegetation (Table 2). Thick *Paspalum* infested habitat was least

TABLE 1

SPECIES RICHNESS IN DIFFERENT HABITATS DURING 1984-85 TO 1987-88

Macro Habitats	Open Water	Sparse vegetation			*Ipomoea*			*Paspalum*				Aggregated
Micro Habitats	Ow	Fl	Sub	Fl+Sub	Ipo	Ipo+fl.	Ipo+Sub	Pas+Ipo	Ps+Ipo+Sub	Pas+fl	Pas	Agg
Winter 84-85	3.5316	2.2781	4.4886	2.0514			2.0959	1.1247	1.107	0.867	1.24	
Summer 85	1.4307	2.8981	2.0959	2.7479		0.691	1.8989	1.661	2.6175			
Winter 85-86	1.9932	2.3666	2.3309	4.8944		1.8365		1.3059			0.7966	
Summer 86	3.9747		4.1359	1.3288	1.1833		1.6314	1.1032	1.9205		0.7686	
Winter 86-87	3.3726	2.55	3.1016	2.4493	1.5389		0.5856	1.248				1.6609
Summer 87	1.4306	0.7966										1.224

TABLE 2

PERCENTAGE COMPOSITION OF MAJOR FISHES RECORDED IN DIFFERENT HABITATS DURING 1985-86 WINTER

Habitat	Species							
	C. pun	C. str	H. fos	C. bat	N. not	L. roh	C. mri	C. reb
OW	2	–	32.2	6.2	11.1	–	14.3	–
Fl	–	8.9	34.7	75	22.2	–	–	50
Sub	5	4.8	–	18.7	22.2	20	–	–
Fl+Sub	–	5	21	–	33.4	80	85.7	50
Ipo	4	–	–	–	–	–	–	–
Ipo + Fl	–	5	–	–	–	–	–	–
Ipo+Sub	–	–	–	–	–	–	–	–
Pas	32.7	28.6	1.7	–	–	–	–	–
Pas+Fl	6.9	–	–	–	–	–	–	–
Pas + Sub	40.6	–	–	–	–	–	–	–
Pas + Ipo	–	47.7	–	–	–	–	–	–
Pas + Scr	8.8	–	–	–	–	–	–	–
Typha + Sub	–	–	1.7	–	11.1	–	–	–

C. pun—*Channa punctatus*, C. str — *Channa striatus*,
H. fos—*Heteropneustes fossilis*, C. bat— *Clarias batrachus*,
N. not—*Notopterus notopterus*, L. roh— *Labeo rohita*,
C. mri—*Cirrhinus mrigala*, C. reb — *Cirrhinus reba*.

preferred by these fishes and that also during summer (Table 3).

Among the non air-breathers, the major carps such as *Labeo rohita* and *Cirrhinus mrigala* showed very narrow preference of habitats, i.e. they were recorded mostly in open water and floating + submerged vegetation. Minor carps such as *Cirrhinus reba*, *Puntius sophore* and *P. sarana* were also recorded mostly in open water. On the other hand, *Notopterus notopterus* was recorded from a wider variety of habitats during the summer period. This species was recorded even from *P. distichum* infested habitats (Table 3).

It is clear from the study that most of the fishes preferred sparse vegetation (i.e. open water, floating, submerged and floating + submerged) and avoided *Paspalum* dominated habitats. Among the preferred ones, submerged vegetation was the most utilised habitat. Thick growth of *Ipomoea* and *Paspalum*, or any other macrophyte, would lead to: (1) inhibition of the free movement of fish, (2) reduction of planktonic food material, and (3) depletion of dissolved oxygen.

Jhingran (1980) discussed the effect of macrophyte on pisciculture and stated that thick growth of macrophyte in water body will severely restrict plankton production, limit the living space of fish and upset the equilibrium of physico-chemical qualities of water. It also leads to imbalance in dissolved oxygen budget, accumulation of deposits leading to siltation. Thick macrophytes provide shelter to the predatory and weed fishes, molluscs and aquatic insects and, obstruct net operations.

TABLE 3

PERCENTAGE COMPOSITION OF MAJOR FISHES RECORDED IN DIFFFERENT HABITATS DURING 1985-86 SUMMER

Habitat	Species							
	C. pun	C. str	H. fos	C. bat	N. not	L. roh	C. mri	C. reb
OW	–	–	21	–	2.9	88.3	17.6	64.2
Fl	21	18.7	30.8	50	17	–	–	–
Sub	28	–	–	–	2.9	11.7	–	35.8
Fl+Sub	–	15.6	–	40	3	–	76.5	–
Ipo	–	50	–	–	–	–	5.9	–
Ipo+Fl	10	6.2	10	10	–	–	–	–
Ipo+Fl	12	–	23.1	–	–	–	–	–
Pas	20	–	–	–	63	–	–	–
Pas+Fl	2	–	–	–	–	–	–	–
Pas+Sub	5	6.2	–	–	11.2	–	–	–
Pas+Ipo+Sub	–	3.3	15.1	–	–	–	–	–

C. pun-*Channa punctatus*, C. str – *Channa striatus*,
H. fos-*Heteropneustes fossilis*, C. bat – *Clarias batrachus*,
N. not-*Notopterus notopterus*, L. roh – *Labeo rohita*,
C. mri-*Cirrhinus mrigala*, C. reb – *Cirrinus reba*.

Parameters such as DO and CO_2 differed considerably between the two macrohabitats. DO and CO_2 are limiting factors for the survival of the fish. According to Alabaster and Llyod (1980) the effect of DO on fish is influenced by several other factors including temperature, which affect the solubility of oxygen in water and also the metabolic rate of poikilotherms. Studies showed that sudden exposure to a moderately high concentration of CO_2 causes a normally tolerable low DO to be fatal. Air-breathers may not be much sensitive to this factor because of the presence of accessory respiratory organs which help the fish to breath air. But for non-air breathers, depletion of DO may cause death. This explains the reason for low species richness in thick vegetation. Individual species tolerance to DO and CO_2 are not studied in detail in natural condition. Between the areas having less vegetation and thick vegetation a prominent difference was noticed. Water with less vegetation had low MOA. In thick vegetation, as the decomposition is more, bicarbonate is added to the water through respiration, and hence, MOA value goes up. The carps being exclusively dependent on dissolved oxygen avoid thick vegetation. However, air-breathers that are not fully dependent on DO in water can survive in the oxygen depleted habitats so they were recorded in thick vegetation.

In brief the two macrohabitats (open water or water with sparse vegetation, and water with thick vegetation) for a certain extent differed in their physico-chemical properties of water also. It can be inferred that habitat segregation of fish is influenced by the type of vegetation and the physico-chemical properties of water, especially DO. Availability of food organisms such as zooplankton and macroinvertebrates may also affect the habitat preference.

On the whole, the widespread infestation of aquatic plants in the Park affects the fish causing them to be in the limited deeper open water area. The result will be reduction in the living space and food, ultimately leading to low ponderal index (Kumar 1991). Increase of thick *Paspalum* mat will allow increase in the population of hardy fishes such as *Channa* sp. and reduction of other minor carps which are also very essential in the diet of piscivorous birds.

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ASIAN AND AUSTRALIAN BIRDS IN THE *HISTOIRE NATURELLE DES OISEAUX D'AFRIQUE* (1796-1813) BY FRANCOIS LEVAILLANT[1]

By L. C. ROOKMAAKER[2]

Key words: Taxonomy, Nomenclature, Asia, Australia, Ornithology, Levaillant 18th Century, Zoology

The Frenchman François Levaillant included in his monumental *Histoire Naturelle des Oiseaux d'Afrique* (6 volumes, 1796-1813) the descriptions and plates of 45 birds known only from Australia and Asian countries, mainly India and the South- East Asian region. Although Levaillant indicated the species by French names only, many scientific names were proposed in the first quarter of the 19th century which were solely based on his work. Out of these, 14 are still in current use for species or subspecies of Asian birds, of which Levaillant's specimens are the types. The history of these specimens and the existence of drawings based on them is briefly discussed.

INTRODUCTION

A taxonomist working on Asian birds would not soon think to consult a volume on the birds of Africa. Yet, such a book appears with some regularity in the synonymies or taxonomic sections of serious text-books like (to give just two examples) Ali & Ripley's HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (cf. 1987) and Ripley's SYNOPSIS (1982). For instance, Ripley (1982 : 270) gave the reference to the original description of *Dicrurus macrocercus* by Vieillot, with the statement that the name was "based on 'Le Drongolon' of Levaillant, 1805, Ois. d'Afr. 4, pl. 174: 72..." In this paper I would like to give some background to this work by Levaillant, while adding a complete list of all Asian birds found there. I have discussed Levaillant's ornithological studies in more detail in my recent book on *The Zoological Exploration of Southern Africa 1650- 1790,* but this title too would not immediately appeal to students of Asian ornithology.

LIFE OF LEVAILLANT

The Frenchman François Levaillant (1753-1828) should be considered one of the pioneer ornithologists of the late 18th century. Born in Suriname (South America) of French parents, educated in France, he decided to travel to the Cape of Good Hope to collect and study birds. He stayed in South Africa from 14 April 1781 to 14 July 1784.

During these years, he undertook two expeditions into the interior. After his return to Europe he wrote two general accounts of his travels first published in French in 1790 and 1795. There were many later editions and translations in all major European languages. Levaillant's main purpose during his travels was to collect bird specimens. Although we are not sure what number of birds he brought home to France, it surely must have been significant. He studied and traded these African birds. He compared them to specimens in European museums and private collections. In the course of his investigations, he came across many birds from all over the world which had not yet been described. Levaillant remained active as a student of or-

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nithology, as author, and probably also as trader of bird skins until the end of his life in 1828.

THE BIRDS OF AFRICA

Levaillant published the results of his ornithological studies in five works, which mainly consisted of descriptions of birds illustrated by plates of each species (often found in coloured plates).

These works appeared in instalments, usually containing descriptions and plates of six birds. His major work is considered to be the *Histoire Naturelle des Oiseaux d'Afrique* [Natural History of African Birds], which appeared in 52 instalments to be bound in 6 volumes between 1796 and 1812 or 1813. In this work he treated 288 birds illustrated on 300 plates.

One would expect that Levaillant would have written about the species which he found in South Africa. While many of those are found there, the book also contains descriptions of other birds. In his text, Levaillant often recorded that he received or saw birds similar to the African species, which he discussed in comparison. His book with the abbreviated title *Oiseaux d'Afrique* or *Ois. Afr.* contains descriptions of 80 species of which Levaillant stated occurred in countries outside South Africa.

The *Oiseaux d'Afrique*, therefore, is quite a mixture. There are two other problems connected with it. First, there has been (and is) some serious doubt about the validity of Levaillant's statements. Some birds in the book are described in great detail, including its habits in the field and Levaillant's assurance that he shot one or more during his African expeditions, while in fact the species was never found there. Notwithstanding these shortcomings, there are many valuable parts which even today should not be overlooked.

The second problem in connection with the work of Levaillant is that he provided the birds only with French names. However, soon after almost all the species were provided with one or more binominal names. My analysis showed that there were at least 315 names based only on the *Oiseaux d'Afrique*, of which quite a number is in current use. The animals described or illustrated should be considered the type specimens of all these species, which means that the *Oiseaux d'Afrique* will continue to be important to taxonomists. The list which follows shows that the book included descriptions of 45 birds occurring or said to occur in the present Asia and Australia. This has resulted in at least 50 new names given on the basis of Levaillant's descriptions only.

There are two questions which I tried to answer in my book of 1989: what happened to the specimens studied by Levaillant, and what other sources exist about their morphology. I have given some clues about the South African species in my book. I shall give some details about the Asian birds here.

COLLECTIONS OF BIRD SPECIMENS

Levaillant brought many birds with him from his South African journey. Their present whereabouts are unknown in almost all cases. These species do not concern us here. In case of species which did not occur in South Africa and which Levaillant treated in the *Oiseaux d'Afrique*, he almost invariably indicated where he saw them. A few notes about four of the main private collections, with which he was familiar, may be given here.

1. *Jacob Temminck*: The treasurer of the Dutch East India Company, Jacob Temminck (1748-1822) had a great interest in natural history and maintained a collection of skins and

other specimens. He probably was helpful in arranging Levaillant's journey. It is certain that Temminck received some birds from Levaillant after his return from the Cape of Good Hope. At the same time, Levaillant spent time with Temminck and in several instances he recorded that a certain bird was found in that collection. A catalogue of the animals preserved there was published in 1807 by the son, Coenraad Jacob Temminck (1778-1858). Later the collection became the nucleus of the national museum of natural history in Leiden, Holland (founded in 1825), the Rijksmuseum van Natuurlijke Historie (RMNH). Many of Temminck's specimens are still found there.

2. *Joan Raye:* The Dutch businessman Joan Raye (1737-1823) was Levaillant's best friend and main contact in Holland. He also maintained a cabinet of natural history, which included birds collected by Levaillant. This collection was auctioned in 1827; the sales catalogue included 1103 bird species. Part of it was bought by the museum in Leiden.

3. *W.S. Boers:* Not much is known about the collection of Boers in The Hague, Holland. However, Levaillant had some contact with Boers and he mentions him a few times in the *Oiseaux d'Afrique*. There is a sales catalogue of this collection of 1797 including 337 birds, but what happened to them is not known.

4. *Levaillant's own collection:* Levaillant himself also had a large collection of birds, consisting of specimens which he brought from the Cape of Good Hope and other specimens which he traded or received otherwise. It is likely that most birds in the *Oiseaux d'Afrique* with unstated depository in fact were in this private collection. Levaillant sold a large part during his life, but unfortunately it has been impossible to determine their present existence (Rookmaaker 1989).

Collections of Watercolours

While the actual specimens studied by Levaillant are very difficult to retrieve (due to uncertain labelling of the old specimens in many museums), there is one other way to get some idea about their appearance. All the birds were illustrated on the plates in *Oiseaux d'Afrique*, but there are also some drawings or watercolours depicting (probably) the same specimens. Although one needs to be careful to generalise, it is possible that some of these watercolours depicting types can shed some light in taxonomic puzzles where the colour of the published plates is important. There are five places known, where such drawings connected with Levaillant's travels and publications are kept (Rookmaaker 1989). Only two need concern us here.

1. *Watercolours in RMNH* [Rijksmuseum van Natuurlijke Historie, Leiden, Holland]. The library of the museum has a set of Levaillant's *Oiseaux d'Afrique* which came from Joan Raye. These volumes contain 53 original watercolours showing birds stated to be in Raye's private cabinet. These drawings are identified below by the prefix RMNH followed by a number (see Rookmaaker 1989: 235-240).

2. *Watercolours in the University of Leiden.* The main library of the Leiden University owns a 4-volume set of the two travel accounts by François Levaillant. These books include 242 original watercolours, showing 163 birds, 33 mammals and some topographical and ethnographical subjects. They too came from the library of Joan Raye. These drawings are mentioned below by the prefix UBL followed by a number (see Rookmaaker 1989: 214-235).

LIST OF ASIAN AND AUSTRALIAN BIRDS

The species in the *Histoire Naturelle des Oiseaux d'Afrique* stated to be from an Asian country or from Australia are listed below. The references in the second line of each entry refer to the book by Levaillant stating plate number, volume and page reference, and its probable date of publication. The page references are to the folio edition, which differ from the quarto editions.

1. *Haliaeetus leucogaster* (Gmelin, 1788)

Plate 5 (Volume 1, pp. 15-17), 1796: Le Blagre

Name based on Levaillant's description:

Falco blagrus Daudin, 1800, II: 70.

Levaillant claimed that he saw this bird on rare occasions in the dry interior of southern Africa. The plate does not represent an African species, but depicts *Haliaeetus leucogaster* from India and South-East Asia, which was known from earlier sources.

2. *Gyps bengalensis* Gmelin, 1788

Plate 11 (Volume 1, pp. 32-33), 1796/97: Le Chaugoun

Names based on Levaillant's description:

Vultur indus J.R. Forster, 1798: xvi, 40.

Vultur chaugoun Daudin, 1800, II: 14.

Levaillant had received a specimen from 'Bengal' where the bird was known as 'chaugoun'. The bird was earlier described by Gmelin as *Gyps bengalensis*. Levaillant's specimen, the type of *V. indus* and *V. chaugoun* apparently was preserved in the Rijksmuseum van Natuurlijke Historie, Leiden (Rookmaaker 1989: 266).

3. *Vultur monachus* (Linnaeus, 1766)

Plate 12 (Volume 1, pp. 34-37), 1796/97: Le Chincou

Names based on Levaillant's description:

Vultur sinensis J. R. Forster, 1798: xvi, 42.

Vultur chincou Daudin, 1800, II: 12.

Linnaeus was the first to name this bird. Levaillant saw a specimen alive in the aviary of Arnoldus Ameshoff (1749-1819). Ameshoff had a small collection of living birds (and mammals?) in his residence near Amsterdam, Holland, where Levaillant visited him either in 1780 or in 1785. The bird was supposed to be from China, but Levaillant does not inform us how it came to Holland or what happened with it after it died. We may assume that the specimen is no longer existing.

4. *Falco chicquera* Daudin, 1800

Plate 30 (Volume 1, p. 84), 1798: Le Chicquera

Names based on Levaillant's description:

Falco chicquera Daudin, 1800, II: 12.

Levaillant described a specimen of this bird which he saw 'dans une collection que j'ai achetée .... faite au Bengal' [in a collection which I bought .... from Bengal]. The current name of the species was proposed by Daudin after Levaillant's description. The type-locality is Bengal. There is a drawing of this species bound in Joan Raye's copy of Levaillant's *Oiseaux d'Afrique* (RMNH 14 in Rookmaaker 1989: 238). It is likely that Levaillant gave the bird to Raye in Amsterdam, because it is mentioned in the catalogue of the sale of Raye's collection in 1827: "7. *Falco chiquera* (sic), le Chiquera" (Raye 1827: 4). It is unknown what happened to it later. There are, therefore, two known depictions of this type specimen, plate 30 in the *Oiseaux d'Afrique* and the watercolour in Raye's copy of Levaillant's *Oiseaux d'Afrique* (RMNH 14 in Rookmaaker 1989: 238). It is likely that Levaillant gave the bird to Raye in Amsterdam, because it is mentioned in the catalogue of the sale of Raye's collection in 1827: "7. *Falco* *chiquera* (sic), le Chiquera" (Raye 1827: 4). It is unknown what happened to it later. There are, therefore, two known depictions of this type specimen, plate 30 in the *Oiseaux d'Afrique* and the watercolour in Raye's copy of the book (now in Leiden).

5. *Circus melanoleucos* (Pennant, 1769)

Plate 32 (Volume 1, pp. 87-88), 1798: Le Tchoug

Levaillant knew this bird from Bengal. No new names were based on his description. One specimen in the collection of Joan Raye in Amsterdam was drawn on two drawings (depicting the whole bird and its head and feet) bound in Raye's copy of Levaillant's *Oiseaux d'Afrique* (RMNH 15, 16). The same bird is mentioned in the catalogue of Raye's sale in 1827: 'no. 22 *Falco melanoleucos*, le Tchoug' (Raye 1827: 5). The present whereabouts of the specimen are not recorded.

6. *Crypsirina temia* (Daudin, 1800)

Plate 56 (Volume 2, pp. 17-18), 1800: Le Temia

Names based on Levaillant's description:

Corvus temia Daudin, 1800: 244.

Corvus varians Latham, 1801: xxvi.

There was only one specimen in Europe when Levaillant compiled his works. He saw it in the collection of Jacob Temminck in Holland and he stated that it had been received from Batavia in Java. Temminck's specimen was listed in the catalogue of the collection compiled by C.J. Temminck (1807: 41) as *Corvus varians* from 'Ceylon'. Later the same specimen was mentioned by Temminck (1838, II: text on Glaucopis), who stated that the bird was in a poor condition, but it was the same as the one figured by Levaillant, because no others had yet become known. It is likely that the skin is still preserved in the Rijksmuseum van Natuurlijke Hitorie in Leiden. Peters *Check-list* (1962, XV: 250) gives the type locality as "Africa, error for Java". Levaillant or Daudin, however, did not refer to its supposed occurrence in Africa.

7. *Urocissa flavirostris* (Blyth, 1846)

Plate 57 (Volume 2, pp. 19-21), 1800: La Pie Bleue

Levaillant knew this bird correctly from China. He had one specimen in his own collection and also saw others owned by Temminck, Boers, C. Gygot-d'Orcy and the Paris museum. There is a drawing similar to the published plate (in reverse) in the RMNH copy of his book (RMNH 29). That drawing has no caption and it is not recorded that Raye owned a specimen. It may be that Temminck's bird was borrowed for the illustration. No new names were based on Levaillant's plate, probably due to confusion with *Urocissa erythrorhyncha* (Boddaert, 1783), but the bird on the plate has a yellow (not a red) bill.

8. Artefact

Plate 58 (Volume 2, pp. 22-23), 1800: La Pie Bleue à Tête Noire

Name based on Levaillant's description:

Corvus melanocephalus Daudin, 1800, II: 241.

Levaillant figured a bird which had come from China. Although he usually mentioned where he saw his specimens, this information is absent in the description of this species. It was probably in his own collection. The bird has never been seen again and must have been composed by a dealer in Europe.

9. *Dendrocitta vagabunda* (Latham, 1790)

Plate 59 (Volume 2, pp. 24-25), 1800: La Pie Rousse

Levaillant received one of these birds from Bengal. It is likely that this means no more than that it was collected somewhere in the Indian region. It is probable that the specimen belonged to the nominate subspecies, even though this cannot be seen on the plate.

10. *Lanius cristatus superciliosus* Latham, 1801

Plate 66 Fig. 2 (Volume 2, pp. 45-47), 1800: Le Rousseau

Name based on Levaillant's description:

Lanius superciliosus Latham, 1801: 20.

According to Levaillant, the bird lived on Java around Batavia (Jakarta). One specimen had been received by Jacob Temminck in Holland, which he gave to Levaillant. The current name of the species is based on this description and plate by Levaillant. It is not possible to retrieve what happened to the type specimen.

11. Artefact

Plate 82 (Volume 2, pp. 92-96), 1801: Le Sicrin

Names based on Levaillant's description:

Corvus crinitus Daudin, 1800, II: 253.

Corvus indicus Wilkes, 1802, V: 242.

Corvus sexsetaceus Shaw, 1809, VII (2): 380.

Levaillant bought his own specimen from a 'dealer of natural history specimens' supposed to be 'des Indes' (from India?). A similar bird was owned by W.S. Boers in Holland. Even though three names were based on the plate, the bird is unknown and must have been made by the dealer.

12. *Prosthemadera novaeseelandiae* (Gmelin, 1784)

Plate 92 (Volume 2, pp. 126-128), 1801-04: La Cravate Frisée

Name based on Levaillant's description:

Sturnus crispicollis Daudin, 1800, II: 314.

One of these birds from the South Seas ('un des îles de la Mer du Sud') was in the collection of C. Gigot-d'Orcy. It had been sent there by 'Woodfort' in London to be painted. It is not very clear why this happened. 'Woodfort' may have been John Alexander Woodford (d. 1817), paymaster in England of French emigres allowances. The species was already known since 1773 when George Forster saw one in Queen Charlotte Sound and several specimens were recorded in England.

13. *Sturnus pagodarum* (Gmelin, 1789)

Plate 95 fig. 1 (Volume 2, pp. 135-136), 1801-04: Le Martin-Brame

On the plate the bird is called 'Martin-Brame', in the text 'Martin-Blanc'. Levaillant stated that it was very common in many parts of India, but he also saw it in South Africa where he killed two of them. The species is unknown in Africa and we must assume that Levaillant did not preserve his African specimens and later confused them with the Indian bird.

14. *Acridotheres ginginianus* (Latham, 1790)

Plate 95 fig. 2 (Volume 2, pp. 137-138), 1801-04: Le Martin Gris-de Fer.

Name based on Levaillant's description:

Gracula grisea Daudin, 1800, II: 286.

Like in the former species of figure 1, Levaillant was confused. He knew that the bird on the plate came from India, but at the same time he stated that he killed five of them in South Africa; he even gave an exact place and date.

15. *Pycnonotus aurigaster* (Vieillot, 1818)

Plate 107 fig. 2 (Volume 3, p. 31), 1801-04: Le Cudor

Name based on Levaillant's description:

Turdus aurigaster Vieillot, 1818, XX: 258.

In this case, one wonders at what mistake Levaillant made. He states that his companion Klaas killed this male bird 'sur les bords du Groot-Vis-Rivière du Pays des Caffres' [on the banks of the Great Fish River in Caffraria]. The bird on the plate is originally only known from Java.

16. *Copsychus saularis* (Linnaeus, 1758)

Plate 109 (Volume 3, pp. 33-34), 1801-04: Le Cadran

Although Levaillant claimed that he saw this bird in South Africa, he recognised it as the 'dial bird' from Bengal described by Albin. It is a purely Indian bird.

17. *Copsychus malabaricus tricolor* (Vieillot, 1818)

Plate 114 (Volume 3, p. 45), 1801-04: Le Merle Tricolor à Longue Queue

Name based on Levaillant's description:

Turdus tricolor Vieillot, 1818, XX: 291.

Levaillant saw one of these birds in Paris in the collection of C. Gigot-d'Orcy. Its provenance was not known but assumed to be the islands of the South Sea. The type locality of *Turdus tricolor* Vieillot was correctly changed to Bantam, West Java. There is no clue what happened to the type specimen.

18. *Pachycephala pectoralis* (Latham, 1801)

Plate 115 (Volume 3, pp. 46-47), 1801-04: La Cravatte Blanche

Names based on Levaillant's description:

Laniarius albicollis Vieillot, 1817, XIII: 299.

Turdus lunularis Stephens, 1826, XIII: 200.

Levaillant saw one specimen in the collection of Jacob Temminck. The same one was listed in Temminck (1807 : 89, no. 462): 'Le merle à cravatte blanche' (without binominal name). Temminck's specimen was reported to have been brought from Batavia, Java. The subspecies cannot be clearly identified on the plate, and it may be added that the locality 'Batavia' could mean no more than that the specimen was sent from there after having been collected elsewhere.

19. *Xanthomyza phrygia* (Shaw, 1794)

Plate 116 (Volume 3, p. 48), 1801-04: Le Merle Ecaillé

Name based on Levaillant's description:

Turdus squameus Vieillot, 1818, XX: 259.

Levaillant had seen one specimen in the collection of Jacob Temminck. It was said to have come from Java. However, this must have been a mistake, because *Xanthomyza phrygia* is only known to occur in Australia.

20. *Stipiturus malachurus* (Shaw, 1798)

Plate 130 fig. 2 (Volume 3, pp. 86-87), 1801-04: La Queue Gazée

Name based on Levaillant's description:

Motacilla fimbriata Wilkes, 1817, XVI: 102.

Jacob Temminck showed one of these birds from Java to Levaillant. Later he may have obtained a second one, as Temminck (1807 : 128) recorded a pair as 'no. 451 *Sylvia malachura*'. The locality must have been mistaken. *Stipiturus malachurus* is known only from Australia.

21. *Dicaeum trochileum* (Sparrman, 1789)

Plate 136 (Volume 3, p. 104), 1801-04: Le Figuier Rouge

Name based on Levaillant's description:

Motacilla amboynensis Wilkes, 1817, XVI: 91.

Levaillant was given two of these birds by W.S. Boers in Holland. They came from Amboina. The species is not known to exist on that island, so there might again be a mistake in the locality.

22. *Parus major cinereus* Vieillot, 1818

Plate 139 fig. 2 (Volume 3, p. 117), 1804: La Mésange Grise au Joue Blanche

Name based on Levaillant's description:

Parus cinereus Vieillot, 1818, XX: 316.

Jacob Temminck received a specimen from Batavia and he donated it to Levaillant. The current name of the subspecies was based on the description by Levaillant. The type locality was correctly recorded as Batavia, Java. There is no trace of the type specimen.

23. *Pycnonotus melanicterus* (Gmelin, 1789)

Plate 140 (Volume 3, pp. 118-120), 1804: Le Cap Nègre

Names based on Levaillant's description:

Aegithina atricapilla Vieillot, 1816, I: 176; *nec Sylvia atricapilla* Linnaeus, 1758.

Parus dubius Wilkes, 1821, XVIII: 727.

Levaillant received six specimens of this bird from Ceylon. The names based on his plate are preceded by the current one given by Gmelin in 1789, with type locality Ceylon.

24. *Aegithina tiphia multicolor* (Gmelin, 1789)

Plate 141 (Volume 3, pp. 121-125), 1804: Le Quadricolor

Name based on Levaillant's description:

Aegithina quadricolor Vieillot, 1816, I: 176.

Levaillant received a specimen from Ceylon. It is unknown what happened to that bird.

25. *Terpsiphone paradisi* (Linnaeus, 1758)

Plates 144-146 (Volume 3, pp. 130-134), 1804,1805: Le Tchitrec bé

There were three varieties known of this bird from Ceylon, probably found in a number of collections in Europe (although these are not identified). It had already been described earlier.

26. *Pericrocotus cinnamomeus* (Linnaeus, 1766)

Plate 155 (Volume 4, pp. 13-15), 1805: L'Oranor

Names based on Levaillant's description:

Muscicapa subflava Vieillot, 1818, XXI: 483.

Muscicapa parus Wilkes, 1818, XVI: 262.

There was one of these birds in the collection of Jacob Temminck, received from Ceylon. It was listed by C. J. Temminck (1807 : 117) as '*Muscicapa malabarica* (Ceylan)'.

27. *Dicrurus leucophaeus* Vieillot, 1817

Plate 170 (Volume 4, p. 48), 1805: Le Drongri

Names based on Levaillant's description:

Dicrurus leucophaeus Vieillot, 1817, IX: 587.

Dicrurus cinereus Swainson, 1837, II: 223.

Levaillant knew (or owned) 13 specimens, all stated to be from Ceylon. This is the type locality of the species, whose description by Vieillot was based on Levaillant's note and plate. The locality was probably a mistake; Tweeddale (1878 : 75) and Vaurie (1949 : 262) corrected the type locality to Java.

28. Artefact

Plate 171 (Volume 4, p. 49), 1805: Le Drongri à Ventre Blanc

Names based on Levaillant's description:

Dicrurus leucogaster Vieillot, 1817, IX: 287.

Muscicapa albiventris Wilkes, 1818, XVI: 272.

Edolius albiventer Voigt, 1831, I: 465.

Jacob Temminck gave two of his specimens originating from Java to Levaillant. One of these was again donated to Mr Gevers in Rotterdam, Holland. The bird has never been seen again and it must have been composed by some dealer or sailor, as found by Tweeddale (1878 : 75), who saw the type specimen in the Rijksmuseum van Natuurlijke Historie, Leiden.

29. *Dicrurus caerulescens* (Linnaeus, 1758)

Plate 172 (Volume 4, pp. 50-51), 1805: Le Drongo Fingah

This species was known from Bengal. Levaillant saw one of them in the collection of W.S. Boers in Holland (who gave it to him).

30. *Dicrurus paradiseus lophorinus* Vieillot, 1817

Plate 173 (Volume 4, p. 52), 1805: Le Drongup

Name based on Levaillant's description:

Dicrurus lophorinus Vieillot, 1817, IX: 587.

Levaillant saw one of these birds in the collection of Jacob Temminck in Holland, which came from 'des Indes'. It was later listed by Temminck (1807: 114) as 'Le grand drongo ou le drong-up des Indes.' The locality 'des Indes' was a general term which may have included Ceylon, the only place where the bird is known to live.

31. *Dicrurus macrocercus* Vieillot, 1817

Plate 174 (Volume 4, p. 53), 1805: Le Drongolon

Names based on Levaillant's description:

Dicrurus macrocercus Vieillot, 1817, IX: 588.

Muscicapa longicauda Wilkes, 1818, XVI: 272.

Muscicapa biloba Lichtenstein, 1823: 52.

Dicrurus indicus Stephens, 1826, XIII (2): 139.

Dicrurus longus Bonaparte, Consp. Av. I: 352.

Levaillant stated that the bird was received in the same shipment as the 'drongup' of plate 173. He didn't say explicitly that it was in Temminck's collection, but maybe that is the inference (not found in Temminck, 1807). It must have been a mixed shipment with animals collected both in India and in Ceylon. The species of this plate 174 is known in peninsular India and the type locality was restricted with some justification to Madras City (Vaurie 1949 : 238).

32. *Dicrurus paradiseus platurus* Vieillot, 1817

Plate 175 (Volume 4, pp. 54-55), 1805: Le Drongo à Raquettes

Name based on Levaillant's description:

Dicrurus platurus Vieillot, 1817, IX: 588.

Levaillant knew a number of specimens in the collections of Jacob Temminck, C. Gigot-d' Orcy and the Paris Museum. They were said to have come from Batavia, Java. The current name of the subspecies was based on Levaillant's description. The type locality was later restricted to Malacca (Tweeddale 1877).

33. *Dicrurus aeneus* Vieillot, 1817

Plate 176 (Volume 4, p. 56), 1805: Le Drongo Bronzé

Names based on Levaillant's description:

Dicrurus aeneus Vieillot, 1817, IX: 586.

Dicrurus aerea Wilkes, 1818, XVI: 272.

Dicrurus aeratus Stephens, 1826, XIII (2): 138.

Edolius metallicus Voigt, 1831, I: 465.

Levaillant had a specimen from Bengal, which is taken as the type locality of this species based on Levaillant's note. He did not state where he saw the specimen, and we may assume that he had it in his own collection. It is not known what happened to it later.

34. *Saxicoloides fulicata* (Linnaeus, 1766)

Plate 188 Fig. 1 (Volume 4, p. 82), 1806: Le Traquet à Queue Striée

Name based on Levaillant's description:

Motacilla rubra Wilkes, 1817, XVI: 86.

Oenanthe ptygmatura Vieillot, 1818, XXI: 436. [Peters *Check-List* has it incorrectly as *ptgymatura*]

Thamnobia rufiventer Swainson, 1832, in Swainson & Richardson, p. 489.

Levaillant knew one specimen from Bengal in the collection of Joan Raye in Amsterdam, but he claimed that he also shot it in South Africa (where it does not occur). Raye's specimen is shown on a drawing bound into Raye's copy of Levaillant's travel account (UBL 114) where the locality is stated to be the 'Pais des Caffres' (Caffraria in South Africa). It is not clear what happened to Raye's specimen; it is not listed in Raye (1827).

35. *Phoenicurus ochuros rufiventris* (Vieillot, 1818)

Plate 188 fig. 2 (Volume 4, p. 83), 1806: Le Traquet à Cul Roux

Names based on Levaillant's description:

Motacilla rubra Wilkes, 1817, XVI: 186.

Oenanthe rufiventris Vieillot, 1818, XXI: 431.

Levaillant knew the bird from the same places as the bird on plate 188 f.1, i.e. Bengal and South Africa. Vieillot's name was based on Levaillant. Vieillot's name is predated by *O. rubra* Wilkes, 1818 by which it should be replaced.

36. *Clamator coromandus* (Linnaeus, 1766)

Plate 213 (Volume 5, pp. 40-41), 1806: Le Coucou à Collier Blanc

Name based on Levaillant's description:

Cuculus collaris Vieillot, 1817, VIII: 229.

In this case, Levaillant was wide off the mark. He said that the species was known in Senegal, while he had also seen it in South Africa. Actually it is an Indian species, unknown in the African continent.

37. *Eudynamys scolopacea* (Linnaeus, 1758)

Plate 214 (Volume 5, p. 42), 1806: Le Coucou à Gros Bec

Levaillant thought that he had seen this bird in Africa (where it does not occur), but he illustrated the text with a specimen from India in the collection of Joan Raye. The same bird was listed in Raye's sales catalogue as 'no. 738 *Cuculus crassirostris,* le coucou à bec gris'.

38. *Centropus nigrorufus* (Cuvier, 1816)

Plate 220 (Volume 5, pp. 58-60), 1807: Le Coucal Noirou

Name based on Levaillant's description:

Cuculus nigrorufus Cuvier, 1816, I: 426.

Cuvier (1816 : 426) only gave the name with reference to Levaillant's plate 220. Levaillant said that he had killed the bird in South Africa, where it does not occur. It is not known which specimen was figured by Levaillant.

39. *Cuculus phasianinus* (Latham, 1801)

Plate 223 (Volume 5, pp. 64-65), 1807: Le Coucal Géant

Names based on Levaillant's description:

Polophilus gigas Stephens, 1815, IX (1): 45.

Corydonix giganteus Vieillot, 1817, XXXIV: 295.

This species was first described by Latham from New Holland (Australia). Levaillant saw one from the same place in the collection of Jacob Temminck in Holland. It is again listed by C.J. Temminck (1807: 59, 188) as 'le coucal-géant ou coucou rayé de blanc de la Nouvelle Hollande, mâle'. It is not known what happened to the specimen.

40. *Phaenicophaeus pyrrhocephalus* (Pennant, 1769)

Plate 224 (Volume 5, pp. 68-69), 1807: Le Malkoha

Levaillant saw several of these birds from Ceylon in a number of collections. One of these owned by Joan Raye in Amsterdam was depicted on a drawing inserted in Raye's copy of the *Oiseaux d'Afrique* (RMNH 38).

41. *Rhamphococcyx curvirostris* (Shaw, 1810)

Plate 225 (Volume 5, p. 70), 1807: Le Malkoha Rouverdin

Names based on Levaillant's description:

Cuculus curvirostris Shaw, 1810, XXI: 905.

Phoenicophaeus tricolor Stephens, 1815, IX (1): 61.

Phoenicophaeus viridis Vieillot, 1817, XVIII: 426.

Levaillant saw one specimen in the collection of Jacob Temminck, supposed to have come from Ceylon. The same bird was listed by C.J. Temminck (1807: 55, 209) as 'Malkoha rou-verdin de Ceylan, mâle'. This was the type specimen, as Shaw based his name on Levaillant's description. Ceylon is an incorrect provenance, as the species only occurs in Java.

42. *Rhytoceros undulatus* (Shaw, 1811)

Plate 239 (Volume 5, pp. 96-97), 1807: Le Calao Javan

This bird was known from Java. Levaillant saw several specimens, among others in the collection of Joan Raye in Amsterdam, also depicted on two drawings in his copies of Levaillant's books (UBL 111, RMNH 50).

43. *Buceros hydrocorax* Linnaeus, 1758

Plate 240 (Volume 5, pp. 98-99), 1807: Le Calao à Casque Plat

The species had earlier been described by Linnaeus.

44. *Caloenas nicobarica* (Linnaeus, 1758)

Plate 279 (Volume 6, pp. 73-76), 1810: Le Colombigalline à Camail

Levaillant said that there were no less than 17 specimens from the Nicobar islands in the collection of Ameshoff in Holland.

45. *Goura cristata* (Pallas, 1764)

Plate 280 (Volume 6, pp. 77-79), 1810: Le Colombi-Hocco

This species is only known from New Guinea. Levaillant saw one in the collection of Boers in Cape Town, which was supposed to have come from Banda. Pallas had made the same mistake in the locality and one wonders how this came into being. Another specimen of the same species owned by Joan Raye was depicted on a drawing inserted in Raye's copy of the *Oiseaux d'Afrique* (RMNH 52).

DISCUSSION

Among the 288 birds treated in Levaillant's *Oiseaux d'Afrique*, we have identified 45 species from Australia and Asia. The localities as mentioned by Levaillant can be further defined: Africa 4, India and Sri Lanka 22, South-East Asia 13, China 3 and Australia 3. These indications were not always correct. This is a general problem in books from that period. The people in Europe depended on specimens brought home by a variety of travellers. Many of these did not consider the scientific value. It is quite likely that birds picked up during the voyage between, for instance, China and the Cape of Good Hope were mixed and later the travellers and traders invented the places of provenance.

Perusal of the above list of 45 species shows another problem with Levaillant's work. Some of his statements were unquestionably false and in some cases one could even suspect him to have known that they were incorrect. He claimed to have shot some birds in Africa (see numbers 1, 15, 36, and 38 above), while no such bird was ever seen there before or after his visit. I very much doubt that Levaillant purposely told lies, although even this has been said (Layard 1867). It is more likely that there was a lack of care in the selection of the illustrations. Levaillant collected a large number of bird skins during his South African travels, which he brought to Europe. Some he kept, others he gave or sold to others (like Temminck and Raye). By the time that he examined his specimens, he must have found that they had deteriorated, lost their colour, or disappeared. His plates were all drawn after skins in Europe and obviously skins in poor condition could not well be used for such purpose. Probably Levaillant then selected (to him) similar birds to be drawn. Hence the confusion.

Among these species, 14 bear names proposed exclusively on the basis of Levaillant's descriptions and plates. These specimens examined by Levaillant are the type specimens of these taxa. Most of these birds must be considered irretrievable, although in some cases it may still exist, and one has the best chance to find them in the Rijksmuseum van Natuurlijke Historie in Leiden, Holland. It has been shown above (no. 35), that the current name *Phoenicurus ochuros rufiventris* Vieillot, 1818 is predated by *Motacilla rubra* proposed by John Wilkes in 1817. This latter name was published in an obscure encyclopedia (Rookmaaker 1989: 192-193), which however does not affect its availability.

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ECOFLORISTIC STUDIES ON THE CHASMOPHYTIC ANGIOSPERMS ON THE FORTWALLS OF PADMANABHAPURAM PALACE[1]

P. PREMA[2]

(*With two text-figures*)

Key words: *Ficus religiosa, Morinda pubescens, Randia malabarica,* Chasmophytic angiosperms

The ecology and distribution of the chasmophytic flowering plants found on the stone crevices of Padmanabhapuram palace fort are described. A total of 40 species of angiosperms were reported. Three species not reported by Gamble in the Flora of the Presidency of Madras have also been collected from the study area. Successional trends have been studied with respect to the migration and ecesis of new germules from the surroundings. The studies suggest that the vegetation constitutes a haphazard covering of plants, representing a process called 'Dominance' out of competition, governed by interaction of plants and their environment.

Padmanabhapuram (8° 35′ N, 77° 05′ E) *c.* 53 km from Trivandrum and is situated to the east of Velimalai hills in Kanyakumari Dt., Tamil Nadu (Fig.1). It was the capital of the erstwhile Travancore state in the 18th Century. The palace at Padmanabhapuram and the town of (75.3 ha.) was surrounded by a square fortification of stone about 4 km in circumference intended to defend the palace and its environs. The wall comprising the fort is *c.* 1 m thick and built with granite up to within *c.* 3 m of the parapets, the remaining portion being laterite.

At the four corners of the fort, there are four main bastions for mounting pieces of artillery (Crossbow-like ballistas or projectiles). The height of the wall varies according to the inclination of the ground, the highest elevation being 8 m and the lowest *c.* 5 m. The well-dressed blocks of granite in their present form are more than 2 centuries old (Fig. 2).

The vertical clefts found at convenient intervals had been used once for effective firing of musketry at close range. But they have in these days, lost what utility they had as defensive works. The present status of the fort wall shows a very weak profile, owing to the overgrowth of vegetation in between the huge blocks of stones.

LITERATURE REVIEW AND PRESENT APPROACH

A few chasmophytes have been listed by Lawrence (1960) in his paper "The vegetation of Kanyakumari District". Henry and Swaminathan (1981) have also made some interesting observations. I have also observed some chasmophytes previously, during the systematic studies of the campus flora of Scott Christian College, Nagercoil, Kanyakumari District. *Ficus religiosa* L., *Andrographis paniculata* (Burm.f.) Wall. ex Nees, *Cryptostegia grandiflora* R. Br., were found to dominate in the walls of the college buildings. When similar dominance was noticed in the palace fort at Padmanabhapuram, a floristic analysis of the chasmophytic angiosperms on the fort wall was thought useful and hence the present study.

Care was taken to collect minute herbs and other ephemeral plants. Complete field notes

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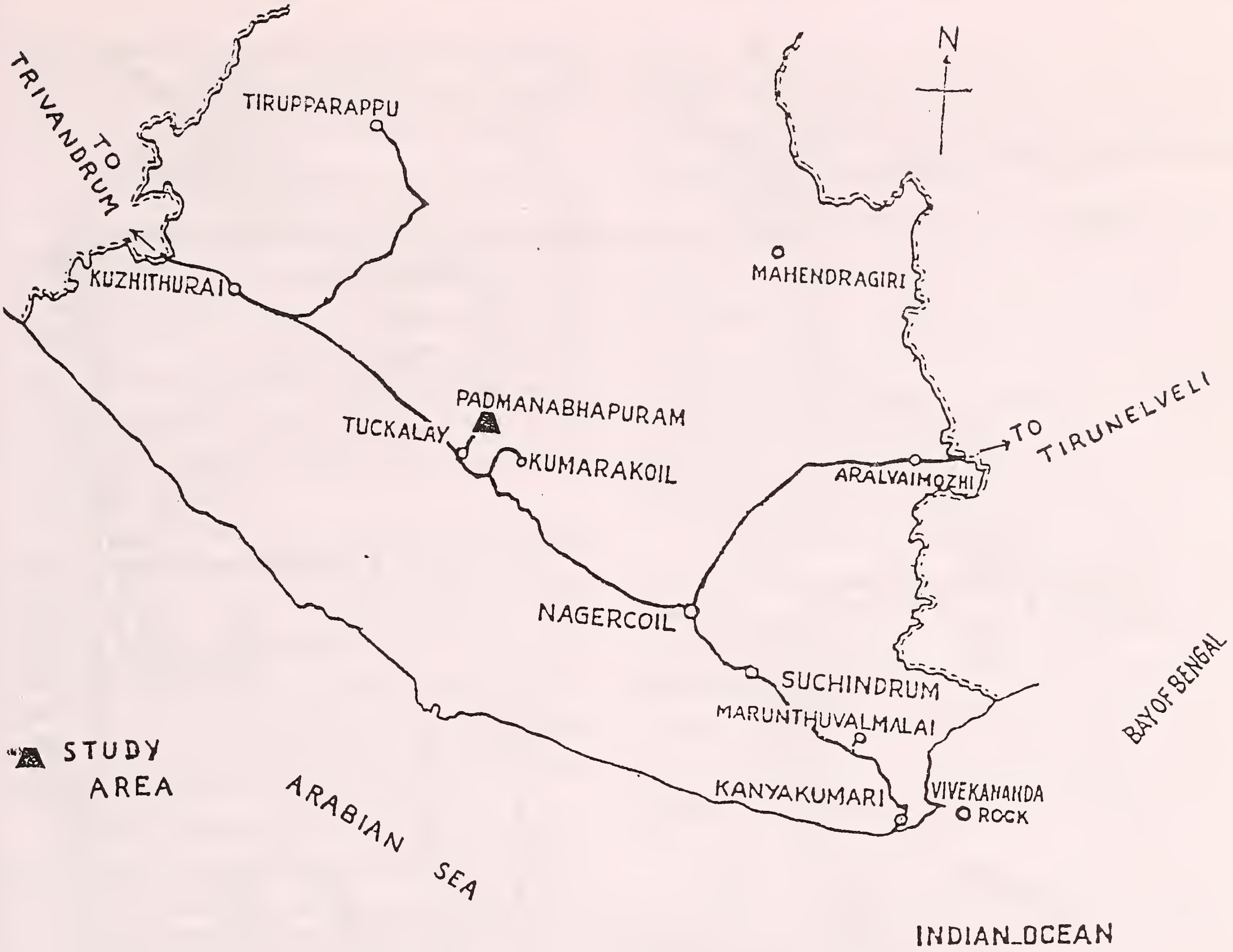
TO TRIVANDRUM
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TO TIRUNELVELI
ARALVAIMOZHI
NAGERCOIL
SUCHINDRUM
MARUNTHUVALMALAI
BAY OF BENGAL
STUDY AREA
ARABIAN SEA
KANYAKUMARI
VIVEKANANDA ROCK
INDIAN OCEAN

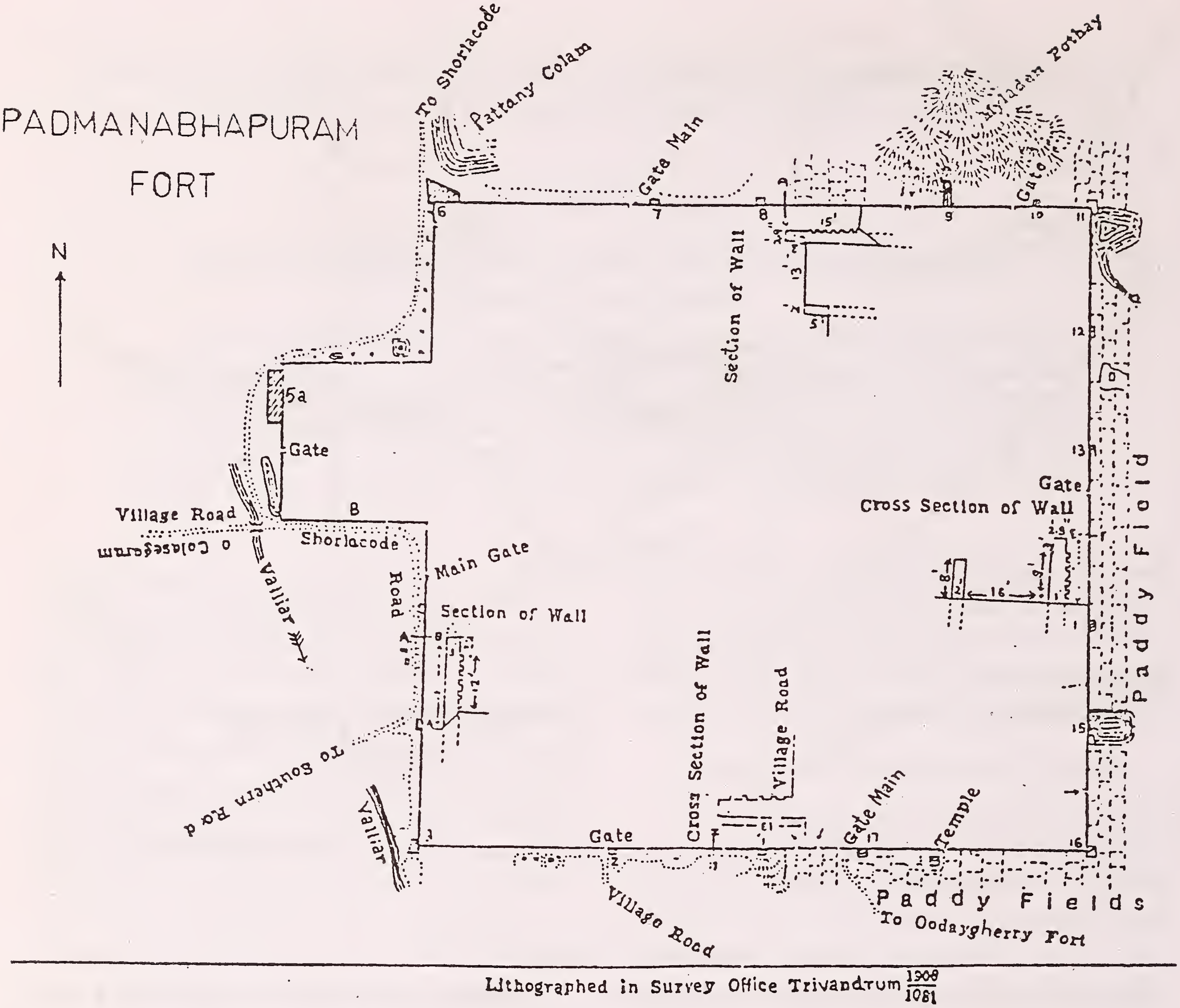
Fig. 1. Map of Kanyakumari District.

were made at the time of collection with special reference to their habitats and associates.

General Aspect of the Vegetation

Chasmophytes are plants growing on plant or soil debris found at places which are generally retentive of moisture. In places like the stone foundation crevices and the interstitial spaces between broken cement plasters, extensive patches of *Tridax procumbens* L., *Vernonia cinerea* L., *Lactuca runcinata* DC., and *Boerhaavia diffusa* L. were seen, forming a pure community. All along the vertical clefts which were partly filled with soil and leaf debris were found, low bushes of *Lantana camara* L., *Randia malabarica* Lamk. and *Barleria cuspidata* Heyne. The angular corners of the cleft below were occupied by grasses like *Eragrostis tenella* L., *Aristida depressa* Retz., *Bulbostylis barbata* Kunth., *Aerva lanata* L., *Leucas aspera* (Willd.) Spreng., *Synedrella nodiflora* L. were found intermittently associated with the other grasses.

In some restricted places, *Antigonon leptopus* Book., and *Melothria perpusilla* Cogn.


PADMANABHAPURAM FORT
N
To Shorlacode
Pattany Colam
Gate Main
Myladay Pothay
Gate
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15'
13'
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Gate
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o Colasegaram
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Gate
Cross Section of Wall
Village Road
Gate Main
Temple
Village Road
Paddy Fields
To Oodaygherry Fort
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3
2
1
Lithographed in Survey Office Trivandrum 1908/1081

Fig. 2. Padmanabhapuram Fort.

were noticed, growing with twisted tendrils upon low scrubs. In certain conditions, *Lantana camara* L., grew around *Morinda pubescens* Smith, flowering profusely with its scarlet flowers standing high above the fort. *Morinda pubescens* Smith, trees have grown freely to form bulky stems which could, easily be detected even from a distance. *Peltophorum pterocarpum* (DC.) Baker ex Heyne, is a new addition to the crowded vegetation on the fort. Several plants grow profusely along the base of the fort wall on the ground soil. Notable among them are *Amaranthus spinosus* L., *Amaranthus viridis* L., *Ruellia tuberosa* L., *Evolvulus nummularius* L., *Sida cordifolia* L., *Byptis suaveolens* L., *Abutilon indicum* G. Don, *Acalypha indica* L., *Lantana camara* L., *Boerhaavia diffusa* L., and *Morinda pubescens* Smith. *Ficus religiosa* L., has colonised every conceivable groove namely, cracks and asphalting work of stone foot paths, inner walls of wells at considerable depths.

SPECIAL FEATURES OF THE VEGETATION

The occurrence of the various plant species is of distributional interest. This paper lists totally 40 species belonging to 38 genera. The shade offered by the tree canopy of the principal tree elements *Ficus religiosa* L., *Morinda pubescens* Smith, keeps the area moist in most places providing a suitable habitat for a number of herbaceous species.

The root biomass of selected plants like *Ficus religiosa* L. is considerably higher than the shoot biomass. Their migration was also very efficient. Ficus roots had the capacity to penetrate wall crevices even up to one mile distance. The Asteraceae members, though lesser in number have a very high area-wise distribution owing to a high rate of seed production.

Certain herbaceous forms like *Tridax procumbens* L., *Lactuca runcinata* DC., *Veronia cinerea* L., *Synedrella nodiflora* L., *Aerva lanata* L., *Hyptis suaveolens* L., *Sida acuta* Burm. f., *Abutilon indicum* G. Don, *Acalypha indica* L. experience either dieback of shoots or are eliminated in the hot summer every year, in the absence of water. The roots of *Ficus religiosa* L., *Ficus bengalensis* L., *Aristida depressa* Retz., are very resistance to high temperatures.

TRENDS IN SUCCESSION

The real causes of the development of vegetation are the responses or adjustments that the existing or successive communities make to the habitat. Development is due to biotic reactions. According to Weaver and Clements (1938), the causes that produce the successive waves of population are migration, ecesis, aggregation, competition and reactions.

Mobility indicates the power of the plant for movement. It depends not only upon the number of germules produced but also is greatly influenced by the morphology of the fruit or seed with reference to the action of the distributive agents. Certain fruits are scattered in consequence of being swallowed especially by birds. The various agents facilitating dispersal for different plant species are presented in Table 1.

Germules of various kinds find their way into communities but only a very few find suitable habitats not already overcrowded in which they can ecize. Competition is greater between individuals or species which make similar demands upon the same supply at the same time. The crowding of the roots upon drainage holes is however an incident for water competition.

Barren stone areas, present only extremes of water content and this excludes all invaders except a few pioneers. Thus the sequence of competition is followed by dominance. *Ficus religiosa* L., behaves like an ecological dominant finding favourable situation on any adverse habitat of the wall.

ENUMERATION OF SPECIES

In the enumeration of the species, the families are arranged according to the Bentham and Hooker's system of classification and presented in Table 2. Species not mentioned by Gamble (1967) are indicated by an asterisk.

TABLE 1

HABITAT AND DISPERSAL PROCESS OF GERMULES OF THE DIFFERENT CHASMOPHYTES STUDIED

(The Symbols namely *, +, 0 represent the vertical cleft, interstitial stone block spaces and Wall foot base respectively)

Sl. No.	Plant Species	Family	Zone of occurrence	Mechanism of dispersal of fruit
1.	*Morinda pubescens* Smith	Rubiaceae	*+0	Zoochory
2.	*Lantana camara* L.	Verbenaceae	*+0	Zoochory
3.	*Randia malabarica* Lamk.	Rubiaceae	*+0	Zoochory
4.	*Ficus bengalensis* L.	Ficoideae	*+0	Zoochory
5.	*Ficus religiosa* L.	Ficoideae	*+0	Zoochory
6.	*Boerhaavia diffusa* L.	Nyctaginaceae	*+0	Zoochory
7.	*Tridax procumbens* L.	Asteraceae	*+0	Anemochory
8.	*Aristida depressa* Retz.	Poaceae	*+0	Anemo & Zoochory
9.	*Eragrostis tenella* L.	Poaceae	*+0	Anemochory
10.	*Passiflora foetida* L.	Passifloraceae	*+0	Zoochory
11.	*Antigonon leptopus* Hook.	Polygonaceae	*+0	Zoochory
12.	*Peltophorum pterocarpum* (DC.) Backer ex Heyne	Caesalpiniaceae	*0	Anemochory
13.	*Azadirachta indica* A. Juss.	Meliaceae	*0	Zoochory
14.	*Bulbostylis barbata* Kunth	Cyperaceae	*0	Anemochory
15.	*Andrographis paniculata* (Burm.f.) Wall. ex Nees	Acanthaceae	*0	Autochory
16.	*Pupalia lappacea* Moq.	Amaranthaceae	+0	Zoochory
17.	*Jatropha gossypifolia* L.	Euphorbiaceae	+0	Zoochory
18.	*Cardiospermum halicacabum* L.	Sapindaceae	+0	Anemochory
19.	*Melothria perpusilla* Cogn.	Cucurbitaceae	+0	Zoochory
20.	*Barleria cuspidata* Heyne	Acanthaceae	+0	Autochory
21.	*Cynodon barberi* Rang.	Poaceae	+0	Anemochory
22.	*Leucas aspera* (Willd.) Spreng.	Lamiaceae	+0	Zoochory
23.	*Carica papaya* L.	Caricaceae	+0	Zoochory
24.	*Aerva lanata* L.	Amaranthaceae	+0	Zoochory
25.	*Synedrella nodiflora* L.	Asteraceae	+0	Anemochory
26.	*Lactuca runcinata* D C.	Asteraceae	+0	Anemochory
27.	*Vernonia cinerea* L.	Asteraceae	+0	Anemochory
28.	*Cryptostegia grandiflora* R. Br.	Periplocaceae	*	Anemochory
29.	*Cuscuta hyalina* Roth.	Convolvulaceae	+	Autochory
30.	*Amaranthus spinosus* L.	Amaranthaceae	0	Zoochory
31.	*Amaranthus viridis* L.	Amaranthaceae	0	Zoochory
32.	*Oldenlandia umbellata* L.	Rubiaceae	0	Autochory

TABLE 1 (Contd.)

33.	_Abutilon indicum_ G. Don	Malvaceae	0	Autochory
34.	_Hyptis suaveolens_ L.	Lamiacea	0	Zoochory
35.	_Ruellia tuberosa_ L.	Acanthaceae	0	Autochory
36.	_Sida acuta_ Burm. f.	Malvaceae	0	Autochory
37.	_Sida cordifolia_ L.	Malvaceae	0	Autochory
38.	_Evolvulus nummularius_ L.	Convolvulaceae	0	Autochory
39.	_Acalypha indica_ L.	Euphorbiaceae	0	Zoochory
40.	_Moringa pterigosperma_ Gaertn.	Moringaceae	0	Autochory

TABLE 2

ENUMERATION OF SPECIES

SL. No.	Name of Species	Family	Habit	Flower colour	Remarks
1.	_Abutilon indicum_ G. Don	Malvaceae	Under shrub	Yellow	Common
2.	_Sida acuta_ Burm. f.	Malvaceae	Under shrub	Yellow	Common
3.	_Sida cordifolia_ L.	Malvaceae	Under shrub	Yellow	Common
4.	_Azadirachta indica_ A. Juss.	Meliaceae	Tree	Pale Yellow	Rare
5.	_Cardiospermum halicacabum_ L.	Sapindaceae	Tendril climber	Pale Yellow	Common
6.	_Moringa pterigosperma_ Gaertn.	Moringaceae	Tree	Pale Yellow	Rare
7.	*_Peltophorum pterocarpum_ (DC.) Backer ex Heyne	Caesalpiniaceae	Tree	Yellow	Rare
8.	_Passiflora foetida_ L.	Passifloraceae	Tendril climber	Pale Green	Abundant
9.	_Carica papaya_ L.	Caricaceae	Tree	Pale Yellow	Rare
10.	_Melothria perpusilla_ Cogn.	Cucurbitaceae	Tendril climber	White	Common
11.	_Morinda pubescens_ Smith	Rubiaceae	Tree	White	Abundant
12.	_Oldenlandia umbellata_ L.	Rubiaceae	Herb	White	Common
13.	_Randia malabarica_ Lamk.	Rubiaceae	Shrub	Pale yellow	Abundant
14.	_Lactuca runcinata_ DC.	Asteraceae	Herb	Purple	Common
15.	_Synedrella nodiflora_ L.	Asteraceae	Herb	Yellow	Common
16.	_Tridax procumbens_ L.	Asteraceae	Herb	Pale yellow	V. Abundant
17.	_Vernonia cinerea_ L.	Asteraceae	Herb	Purple	Common
18.	_Cryptostegia grandiflora_ R. Br.	Periplocaceae	Woody twiner	Pink	Rare
19.	_Cuscuta hyalina_ Roth	Convolvulaceae	Parasite	Pale yellow	Common
20.	*_Evolvulus nummularius_ L.	Convolvulaceae	Prostrate herb	White	Rare
21.	_Andrographis paniculata_ (Burm. f.) Wall. ex Nees	Acanthaceae	Herb	Violet	Common
22.	_Barleria cuspidata_ Heyne	Acanthaceae	Herb	Purple	Common
23.	_Ruellia tuberosa_ L.	Acanthaceae	Herb	Purple	Rare
24.	_Lantana camara_ L.	Verbenaceae	Shrub	Scarlet	Abundant
25.	_Hyptis suaveolens_ L.	Lamiaceae	Herb	Purple	Common
26.	_Leucas aspera_ (Willd.) Spreng.	Lamiaceae	Herb	White	Rare
27.	_Boerhaavia diffusa_ L.	Nyctaginaceae	Herb	Pink	V. Abundant
28.	_Aerva lanata_ L.	Amaranthaceae	Herb	White	Common
29.	_Amaranthus spinosus_ L.	Amaranthaceae	Herb	Green	Common
30.	_Amaranthus viridis_ L.	Amaranthaceae	Herb	Green	Common
31.	_Pupalia lappacea_ Moq.	Amaranthaceae	Herb	Green	Common
32.	_Antigonon leptopus_ Hook.	Polygonaceae	Tendril climber	Pink	Abundant
33.	_Acalypha indica_ L.	Euphorbiaceae	Herb	Green	Rare
34.	_Jatropha gossypifolia_ L.	Euphorbiaceae	Shrub	Red	Rare
35.	_Ficus bengalensis_ L.	Ficoideae	Tree	Yellow	Abundant
36.	_Ficus religiosa_ L.	Ficoideae	Tree	Yellow	V. Abundant
37.	_Bulbostylis barbata_ Kunth	Cyperaceae	Herb	Green	Common
38.	_Aristida depressa_ Retz.	Poaceae	Herb	Green	Abundant
39.	_Cynodon barberi_ Rang.	Poaceae	Herb	Green	Common
40.	*_Eragrostis tenella_ L.	Poaceae	Herb	Green	Abundant

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STUDIES ON THE GENITALIA OF THE TYPE-SPECIES OF SOME OPHIDERINES (LEPIDOPTERA : NOCTUIDAE)[1]

AJAI SRIVASTAVA[2] AND H.S. ROSE[3]

(*With thirty two text-figures*)

Key words: Noctuid moth, *Plecoptera*, *Chrysopera*, *Ischyia*, *Sympis*, *Calesia*, genitalia, uncus, juxta

Seventy species of noctuid moths referable to forty-six genera of subfamily Ophiderinae, were collected from climatically diverse regions of north and north eastern India. Out of these, the following species, i.e. *Lacera alope* (Cramer), *Ramadasa pavo* Walker, *Plecoptera reflexa* Guenée, *Lyncestis amphix* (Cramer), *Chrysopera combinans* (Walker), *Ischyia manlia* (Cramer), *Hypospila bolinoides* (Guenée), *Sympis rufibasis* Guenée, *Oxyodes scrobiculata* (Fabricius), and *Calesia dasyptera* Kollar are the type-species pertaining to different genera. These have been assigned status on the basis of the description of the various constituent parts of their male and female genitalia. Thus it has been established that genitalia components form an excellent basis of diagnosis of noctuid species.

INTRODUCTION

Hampson (1894) while characterising different genera, rightly relied upon various morphological, taxonomic characters, namely labial palpi, the antennae and the maculation of the fore and the hindwings. He, however, could not realise taxonomic significance of external genitalia and thus did not include its structure under the diagnostic features of the genera and species. The significance of genital armature in the lepidopterous taxonomy has been realised for quite some time now.

Beuthene-Baker (1914) identified its great value in taxonomy, phylogeny and considered the structure of genitalia of utmost value in the discrimination of the species and genera. Busck and Heinrich (1921) discussed the systematic importance of the male genitalia in Microlepidoptera. Eyer (1926a) laid stress on the use of male genitalia in the characterisation of Homoneura and Heteroneura in the separation of their constituent families and in the determination of relationship among them. Eyer (1926b) discussed the morphological significance of juxta in the male genitalia of lepidoptera and considered the loss of juxta to mark a high degree of genital specialisation.

Other authors who used the female genitalia in lepidoptera as a taxonomic measure were Philpott (1927), Busck (1931), Diakonoff (1937), Pierce and Metcalfe (1936), Borner (1939). Engelhardt and McElvare (1941) stressed the importance of genitalia at the specific level and expressed the view that during revisional studies, greater dependence should be placed on the internal genitalia.

The other workers who considered genitalia as a reliable taxonomic tool included Pierce (1942, 1952), Stempffer (1947), Pavolny (1957) and Niculescu (1967a, 1967b, 1967c, 1968, 1969) and Zangheri (1969). They suggested that the use of the structure of genitalia should be made in association with the study of other mor-

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phological and biological characters of the taxon under investigation. These considerations necessitated more detailed observations on the structure of male and female genitalia of the type-species of subfamily Ophiderinae from north and north-eastern India. Among these, ten species are the type-species of different genera. In the terminology for naming the various parts of the genitalia Klots (1970) has been followed.

MATERIAL AND METHODS

The specimens have been collected either from the fluorescent tubes or by using a portable light trap (fitted with mercury vapour lamp, 125 watts), especially designated by Common (1959) for the collection of lepidopterous fauna. The collected specimens were killed with vapours of ethyl-acetate in a killing bottle. For preparing the permanent mounts of male genitalia, the entire abdomen was kept in 10% KoH overnight to soften the chitin and to dissolve the muscles and other soft parts.

The boiling of KoH solution damaged the genitalia and was, therefore avoided. The KoH treated material was washed in distilled water, before dissecting it in 10% alcohol solution. After giving two/three washing, the aedeagus was pulled out and the vesica everted out with the help of five curved needles. The material was then transferred to 30% alcohol before staining in chlorazol Black E (Robinson 1976). After dehydration, the preparation was passed from absolute alcohol to Euparal Essence (the Euparal solvent) which cleans it. The genitalia and abdomen were added to a small drop of Euparal on a Slide.

The coverslips was gently lowered on to the preparation, care being taken not to allow the genitalia to roll, bubbles to lodge or the aedeagus to float out from under the coverslip. As usual, after mounting, the slides were dried in an oven set at 45°C for 48 hours. The sketches of the genitalia were made on graph paper with the help of a square ocular grid under Zoom binocular microscope.

OBSERVATIONS AND DISCUSSION

Lacera alope (Cramer)

Cramer, 1780, Vitlandsche Kapellen 3: 168, pl. 286, figs, E, F. (*Phalaena*).

Genitalia MALE (Figs. 1, 2): Uncus well sclerotised, curved ventrad, furnished with tuft of hairs towards distal portion, a highly sclerotised spine present at extreme distal end; tuba-analis with scaphium; tegumen broad, lightly sclerotised throughout the length; vinculum broad v-shaped; saccus conical; valva sclerotised throughout the length; costa marked, distinct process hood like arises from costa, the latter joins with cucullus, sacculus rolled on opposite face of valva, cucullus and valvula membranous, with fine hairs; transtilla membranous, juxta sclerotised broad, tube like; aedeagus slightly curved, highly sclerotised throughout the length, vesica with spine like cornutus.

FEMALE (Fig. 3): Ovipositor lobes well developed, finely setosed; posterior apophyses similar to anterior apophyses; ostium bursae cup-shaped, sclerotised; ductus bursae short tube, sclerotised; corpus bursae elongated, balloon like, thin walled, signum wanting.

REMARKS: The species has been directly compared with reference collections at the forest Research Institute, Dehradun. The male and female external genitalia of this type-species are being illustrated for the first time.

Ramadasa pavo (Walker)

Walker, 1856, List specimens Lepid Insects Colln. Br. Mus. 9: 147 (*Chasmina*).

Genitalia MALE (Figs. 4,5): Uncus long simple, curved at tip and highly sclerotised, almost covered by long hairs, arising from basal portion; socci conspicuous; tegumen narrow, well sclerotised; vinculum well developed, saccus reduced; valva uniformly sclerotised throughout the length, costa well marked, sacculus well developed, harpe present, curved outwards; transtilla well sclerotised, band like, juxta well developed, lightly sclerotised; aedeagus at moderate length, ductus ejaculatorius enters approximately from middle; vesica with three group of teeth like cornuti.

FEMALE (Fig. 6): Ovipositor lobes well sclerotised, brood finely setosed, anterior apophyses shorter than posterior ones, rod like, slightly swollen at tip; ostium bursae highly sclerotised, inverted bell shaped; ductus bursae short, ductus seminalis departs from posterior end of corpus bursae; corpus bursae elongated, with striations all over the body.

Plecoptera reflexa Guenée

Guenée, 1852, in Boisduval and Guenée, Hist. nat. Insects (Lepid.) 6: 430 (*Plecoptera*).

Genitalia MALE (Figs. 7, 8): Uncus bifurcated at middle into two process, the left side's process long bent downwards, beset with fine seta towards distal end, the other process some what straight, common stalk beset with long hairs; tuba-analis lightly sclerotised; tegumen broad, produced into two flape like structure, sclerotised; vinculum narrow, saccus somewhat rounded; valva with well developed costa with prominent costal process, sacculus well sclerotised; harpe prominent bifid at distal end, sclerotised; transtilla membranous, juxta not so modified, simple; aedeagus moderately long, stout, uniformly sclerotised; visica with two large cornuti, one straight, the other one slightly curved.

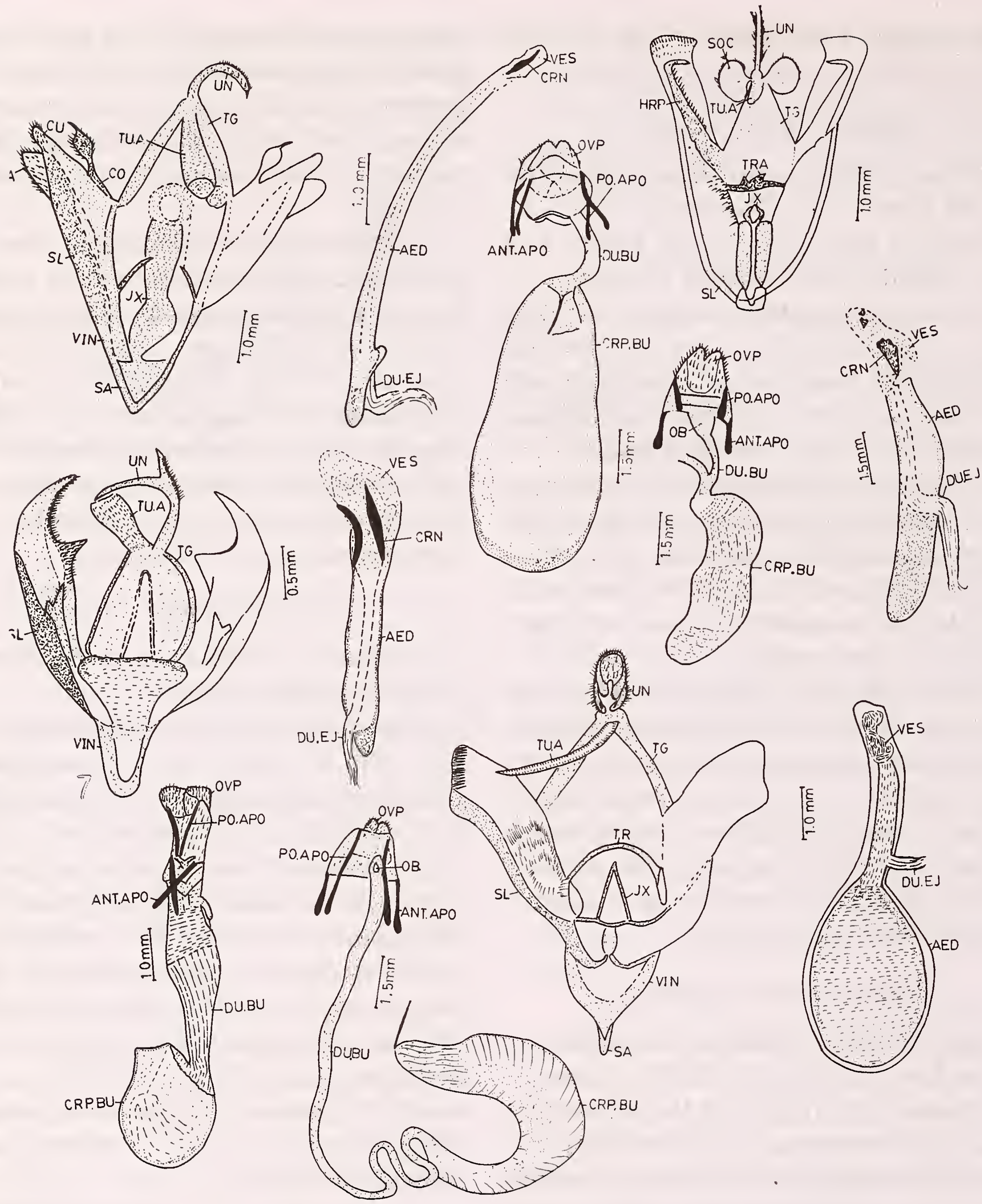
FEMALE (Fig. 9): Ovipositor lobes broad, well sclerotised, setosed; posterior apophyses thinner, lightly sclerotised; anterior apophyses rod like, well sclerotised, with tip swollen; ductus bursae long, anterior half uniformly sclerotised, with longitudinal ridges on its wall, the posterior part comparatively less sclerotised; ductus seminalis departs from posterior part of ductus bursae; corpus bursae simple, membranous more or less cup like.

Lyncestis amphix (Cramer)

Cramer, 1777, Uitlandsche Kapellen, 2: 59, pl. 134, fig. e (*Phalaena*).

Genitalia MALE (Figs. 10,11): Uncus quadrifid, with two upper lips and two lower lips, sclerotised, tuba analis well developed; tegumen well developed, lightly sclerotised; vinculum broad, saccus conical; valva simple, costa prominent, sacculus well developed, sclerotised, distal portion of valva with well developed corona arranged in regular fashion, harpe, ampulla lacking; transtilla highly sclerotised, strip like, juxta well sclerotised, triangular in shape; aedeagus characteristic type with more or less rounded in shape at proximal end, distal end elongated, tube like, vesica with large number of spine like cornuti.

FEMALE (Fig. 12): Ovipositor lobes well developed, furnished with fine setae; posterior apophyses much longer than anterior ones; ostium bursae simple; ductus bursae extremely long tube like, sclerotised; corpus bursae "C" shaped, thick walled with rounded apical end,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Figs. 1, 2. Male genitalia of *Lacera alope* (Cramer); 3. Female genitalia of *L. alope* (Cramer), 4, 5. Male genitalia of *Ramadasa pavo* (Walker); 6. Female genitalia of *Ramadasa pavo* (Walker); 7, 8. Male genitalia of *Plecoptera reflexa* Guenée; 9. Female genitalia of *P. reflexa* Guenée; 10, 11. Male genitalia of *Lyncestis amphix* (Cramer); 12. Female genitalia of *L. amphix* (Cramer). (See abbreviations on p. 222) ductus seminalis departs from extreme terminal end of corpus bursae.

Chrysopera combinans (Walker)

Walker, 1858, List specimens Lepid Insects Colln. Br. Mus. 14: 1399 (*Achaea*).

Genitalia MALE (Figs. 13, 14): Uncus strongly curved ventred, sclerotised, simple, pointed at tip, beset with fine setae; tegumen well developed, sclerotised; vinculum well developed; saccus reduced; valva simple, uniformly sclerotised throughout, costa demarcated, sacculus well developed, harpe present lightly sclerotised, beset with fine setae; transtilla simple, juxta highly sclerotised, well developed, aedeagus of moderate length, vesica with large number of spine like structures.

FEMALE (Fig. 15): Ovipositor lobes well developed, sclerotised, finely setosed; anterior apophyses similar to posterior ones; ostium bursae simple not sclerotised; ductus bursae long, thin tube like; ostium bursae simple, globular membranous.

Ommatophora luminosa (Cramer)

Cramer, 1780, Uitlandsche Kapellen 3: 147, pl. 274, fig. D (*Phalaena*).

Genitalia MALE (Figs. 16, 17): Uncus curved, ventral sclerotised, beset with fine setae, narrow at proximal end, while broader in middle, giving the appearance of hood, tip pointed; tegumen broad, well developed, highly sclerotised, vinculum broad, well marked, saccus wanting; valva sclerotised, costa reduced, sacculus well marked, ampulla somewhat bifid, distal end of valva differentiated into cucullus and valvula; transtilla well marked, highly developed, juxta well sclerotised; aedeagus moderately long, curved in middle, vesica with large number of teeth like structures.

Remarks: The species has been compared with the reference collection at the Forest Research Institute, Dehradun. The study of the male and female genitalia of this species, being the type-species and the inclusion of these structures has definitely improved the diagnosis of the genus *Ommatophora*

Ischyia manlia (Cramer)

Cramer, 1776, Uitlandsche Kapellen *1:* 144, pl. 92, Fig. A (*Phalaena*).

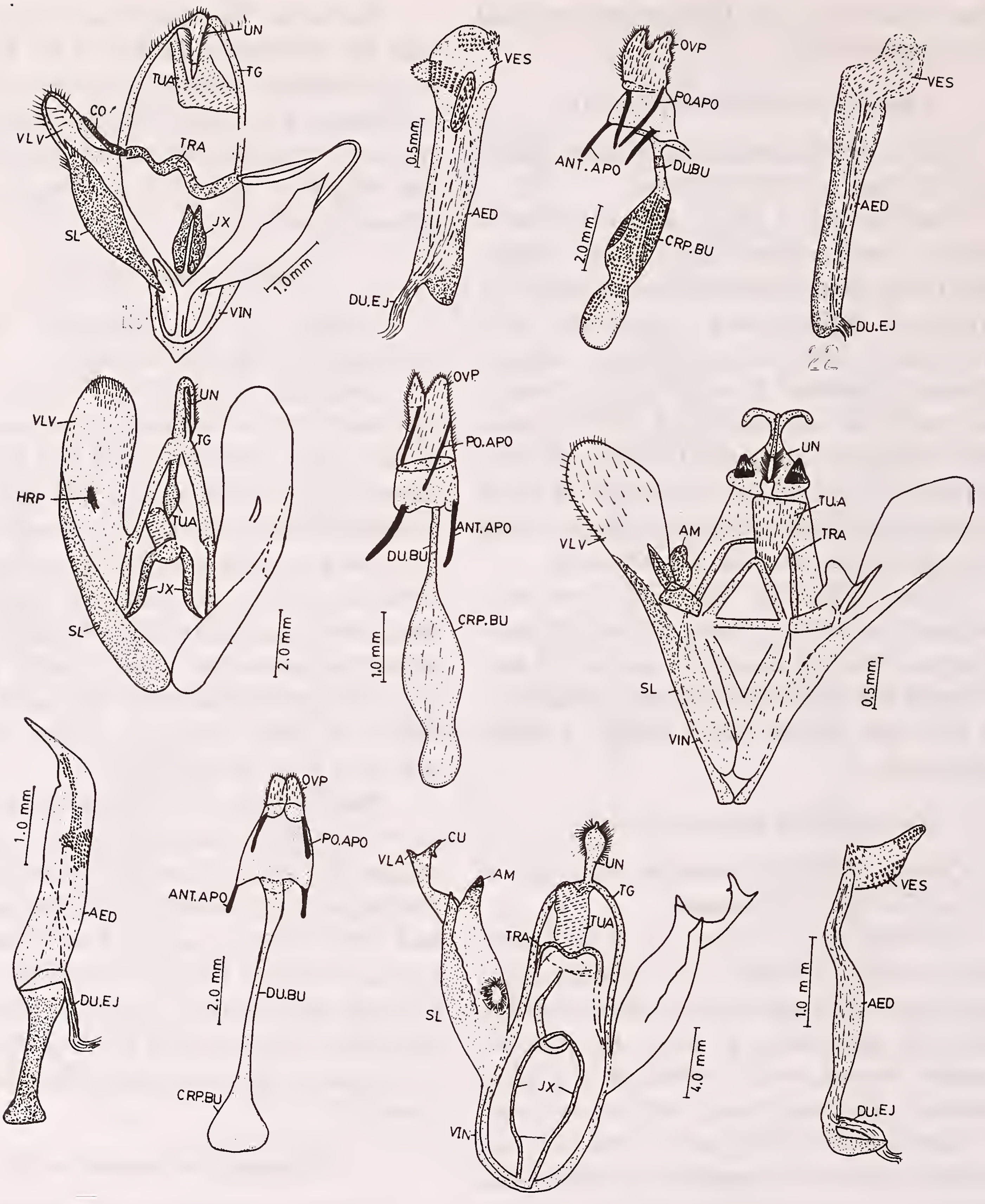
Genitalia MALE (Figs. 18,19): Uncus simple, sclerotised, curved ventrad, more or less sickle shaped, furnished with fine hairs, spine present at terminal end; scaphium distinct, tegumen broader anteriorly, sclerotised, beset with five setae; vinculum well developed, saccus conical; valva with costa and sacculus well demarcated; transtilla well sclerotised; juxta well developed, sclerotised, with forked posterior end; aedeagus of moderate length, with differentiation into base and apex; vesica with three groups of spine like structures.

FEMALE (Fig. 20): Ovipositor lobes well sclerotised, finely setosed; posterior apophyses longer than anterior apophyses; ostium bursae simple; genital plate distinct; ductus bursae short and sclerotised at middle thus forming colliculum; corpus bursae elongated, bilobed, anterior lobe smaller, posterior lobe longer, decorated with striations all over the surface, only posterior parts of anterior lobes shows striations.

Hypospila bolinoides Guenée

Guenée, 1852, in Boisduval and Guenée, Hist. nat. Insects (Lepid.) *7:* 358 (*Hypospila*).

Genitalia MALE, (Figs. 21, 22): Uncus strongly curved ventrad, sclerotised, produced into two process at middle, bifid; tegumen long,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Figs. 13, 14. Male genitalia of *Chrysopera combinans* (Walker); 15. Female genitalia of *C. combinans* (Walker); 16, 17. Male genitalia of *Ommatophora luminosa* (Cramer); 18, 19. Male genitalia of *Ischyia manlia* (Cramer); 20. Female genitalia of *Ischyia manlia* (Cramer); 21, 22. Male genitalia of *Hypospila bolinoides* Guenée; 23. Female genitalia of *H. bolinoides* Guenée. (Abbreviations on p. 222) narrow, well developed, highly sclerotised; tuba-analis prominent; vinculum broad, V-shaped; valva symmetrical, uniformly sclerotised throughout, costa reduced, cucullus well marked, ampulla quadrifid, lightly sclerotised; transtilla membranous, juxta well sclerotised, triangular in shape; aedeagus moderately long, uniformly sclerotised throughout the length; vesica simple.

FEMALE (Fig. 38): Ovipositor lobe well sclerotised, beset with fine setae, anterior apophyses broader, rod like longer; posterior apophyses shorter in length, thinner ostium bursae simple; ductus bursae short, narrow tube-like, sclerotised uniformly; corpus bursae bilobed, posterior lobe elongated, anterior lobe shorter, signum absent.

Sympis rufibasis Guenée

Guenée, 1852, in Boisduval and Guenée, Hist. nat. Insects (Lepid.) 7: 343 (*Sympis*).

Genitalia MALE (Figs. 24, 25): Uncus sclerotised, bent at right angle distally, beset with fine setae, spine like structure present at tip; tuba-analis well marked; tegumen broad, well developed, lightly sclerotised; vinculum narrow, saccus reduced; valva uniformly sclerotised; costa well differentiated by costal process; sacculus well marked, ampulla conspicuous, harpe reduced, valvula produced into conical process at terminal end; transtilla membranous; juxta well developed, highly sclerotised blunt anteriorly, somewhat conical posteriorly; aedeagus long, slender, lightly sclerotised throughout the length, vesica with group of spine like cornuti.

FEMALE (Fig. 26): Ovipositor lobes well developed, broad well sclerotised, finely setosed; posterior apophyses slightly longer than anterior apophyses; ostium bursae simple, genital plate well developed more or less horse shoe shaped; ductus bursae short with striation on its wall; corpus bursae thin walled, small, globular.

Oxyodes scrobiculata (Fabricius)

Fabricius 1775, Syst. Ent.: 592 (*Noctua*).

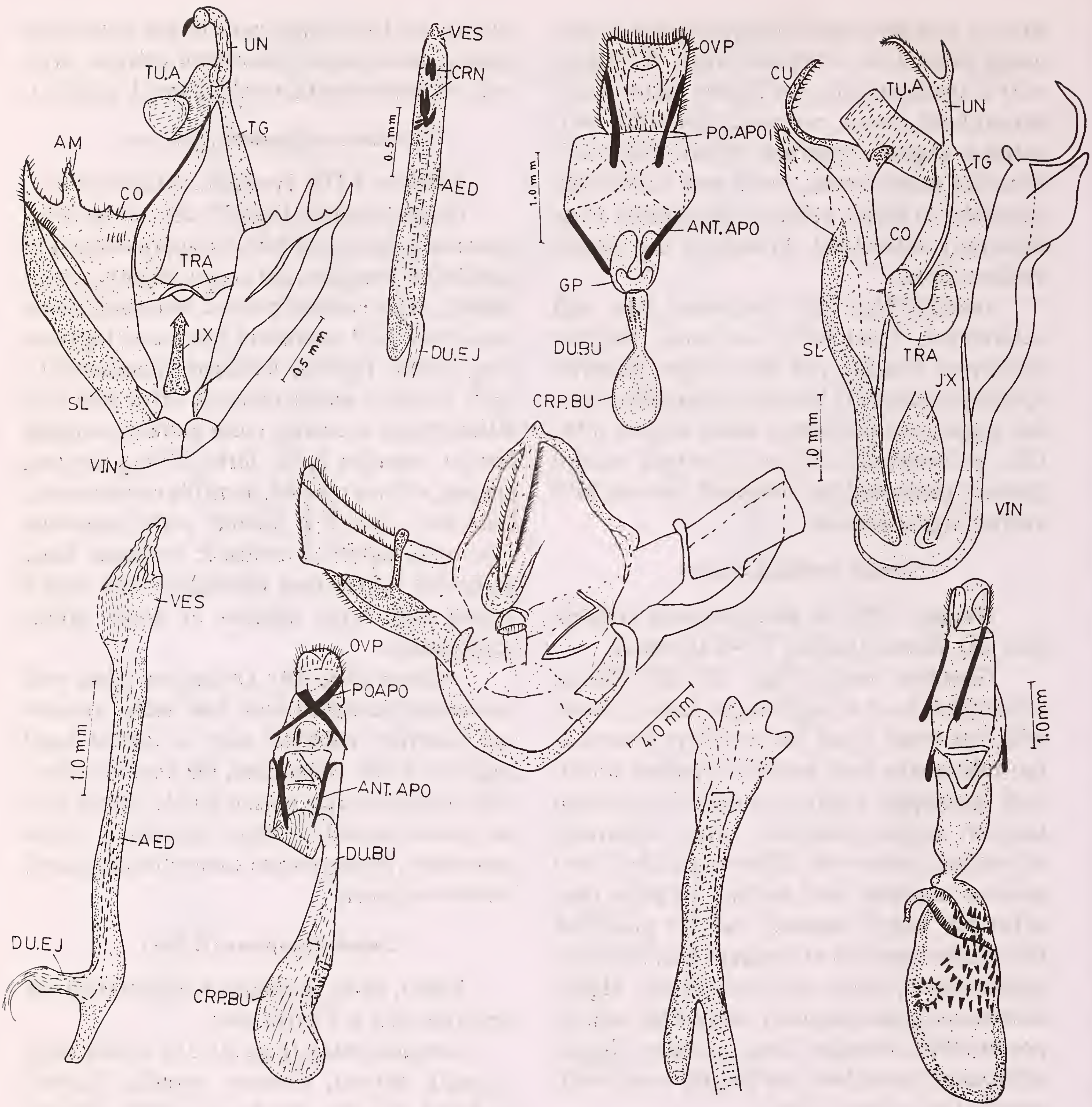
Genitalia MALE (Figs. 27, 28): Uncus long, sclerotised, setosed, bifurcated approximately at middle into two parts, left longer, slightly curved distally, right shorter, pointed terminally; tuba analis with well prominent scaphium; tegumen long, narrow, lightly sclerotised; vinculum obliquely rounded, saccus reduced; valva with well differentiated sacculus, costa marked, ampulla present, cucullus in the form of long tapering process, valvula pointed, transtilla membranous, band like, curved at middle; juxta somewhat semi-oval, lightly sclerotised; aedeagus long, uniformly sclerotised throughout the length vesica with large number of dents, slight sclerotisation.

FEMALE (Fig. 29): Ovipositor lobes well developed, furnished with fine setae; anterior and posterior apophysis more or less of equal length, rod like, sclerotised, the anterior somewhat thinner; ostium bursae simple, ductus bursae dorso-ventrally flatten, sclerotised, wider posteriorly; corpus bursae somewhat elongated, broader anteriorly.

Calesia dasyptera (Kollar)

Kollar, 1844, in Huguel Kaschmir und das Reich der siek 4: 476 (*Erebus*).

Genitalia MALE (Figs 30, 31): Uncus long, strongly curved, slender, spindle shaped, produced to a fine tip: beset with long hairs; tuba-analis well developed; tegumen broad, well sclerotised; vinculum broad, saccus obliquely rounded; valva with costa differentiated, sacculus well prominent with a additional lobe like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Figs. 24, 25. Male genitalia of *Sympis rufibasis* Guenee; 26. Female genitalia of *S. rufibasis* Guenée; 27, 28. Male genitalia of *Oxyodes scrobiculata* (Fabricius); 29. Female genitalia of *O. scrobiculata* (Fabricius); 30, 31. Male genitalia of *Calesia dasyptera* (Kollar); 32. Female genitalia of *C. dasyptera* (Kollar). (See abbreviations on p. 222).

structure, ampulla well developed with swollen terminal end; rest portion of valva lightly sclerotised, furnished with long hairs; transtilla partially sclerotised, juxta well sclerotised; aedeagus moderately long, slightly curved at middle, vesica lightly sclerotised.

FEMALE (Fig. 32): Ovipositor lobes well developed, lightly sclerotised, finely setosed, posterior apophyses much longer than anterior apophyses; anterior apophyses short rod like; ostium bursae with margin sclerotised; ductus bursae short, much sclerotised with broader posterior region and tube like anterior region; corpus bursae somewhat elongated, bag like with large number of spine present at one side proximally, a thin boll like structure, having spines arranged all around it, present signum; ductus seminalis depart from an hook like structure near proximal region of corpus bursae.

ACKNOWLEDGEMENTS

Thanks are due to Mr J. D. Holloway of the British Museum (Natural History), London, Mr. Pratap Singh, Forest Research Institute, Dehradun and Mr I. J. Gupta of the Zoological survey of India for their help to compare the species with those available in reference collections lying in respective museums. We wish to express our appreciation to Mr Hans Raj Sharma, who typed this manuscript.

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Abbreviations

AED, Aedeagus; AM, Ampulla; ANT. APO, Anterior apophysis; CO, Costa; CRN, Cornutus; CRP. BU, Corpus bursae; CU, Cucullus; DU. BU, Ductus bursae; DU. EJ, Ductus ejaculatorius; GP, Genital plate; HRP, Harpe; JX, Juxta; OB, Ostium bursae; OVP, Ovipositor lobes; PO. APO, Posterior apophysis; SA,, Saccus; SL, Sacculus; SOC, Socii; TRA, Transtilla; TG, Tegumen; TU.A, Tuba analis; UN, Uncus; VES, Vesica; VIN, Vinculum; VLA, Valvula; VLV, Valva.

CONTRIBUTIONS TO THE BIOLOGY OF *JAPALURA TRICARINATA* AND *J. POLYGONATA* (SAURIA : AGAMIDAE)[1]

W. Kästle[2], H. H. Schleich[3] and K. B. Shah[4]

Key words: Agamid lizards – *Japalura tricarinata, J. polygonata*, habitat, distribution, ethology, ultra structures

PART I. DISTRIBUTION AND HABITAT OF *JAPALURA TRICARINATA* (BLYTH, 1853)

(*With three text-figures*)

The habitat of *Japalura tricarinata* in the Phulchoki region near Kathmandu, Nepal, is described with emphasis on vegetation and climate. Field observations and new data on the distribution of this species in Nepal are presented.

1. General distribution of *Japalura tricarinata*

Geological and paleontological data document that during Pleistocene/Holocene times the Kathmandu valley was filled by a lake which finally drained via Chobar valley (Sah *et al.* 1991). With rising temperatures in the Holocene, *Japalura tricarinata* withdrew into mountaineous areas and there are probably other regions, e.g. Mt. Damadar, Mahabharat Mountains, from which new records can be expected. The whole range of this species forms a narrow strip along the Himalayans for a length of about 600 km.

2. Habitat of *Japalura tricarinata* in the Phulchoki area

The village of Phulchoki lies 18 km southeast of Kathmandu. Attaining 2715 m Mount Phulchoki is the highest peak near Kathmandu valley. Its area spreads over 40 sq. km and is frequently visited by hikers.

2.1. **Climate:** There is no meteorological station on Phulchoki itself and climatic condi-

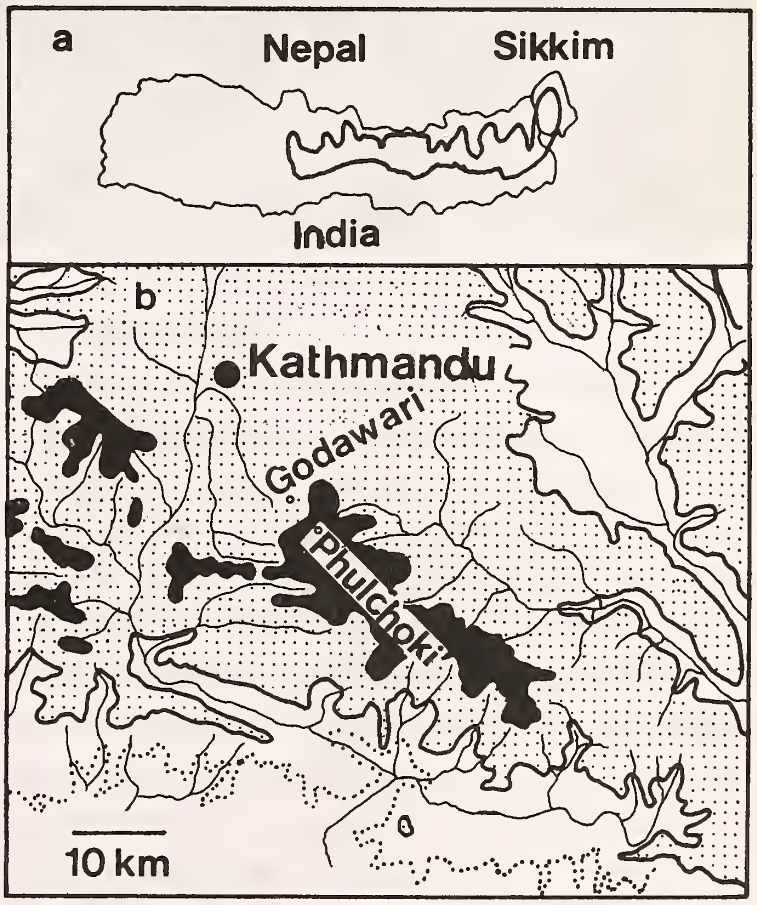

Fig. 1. a: Distribution limits of *Japalura tricarinata*. b. Situation of the Phulchoki area.

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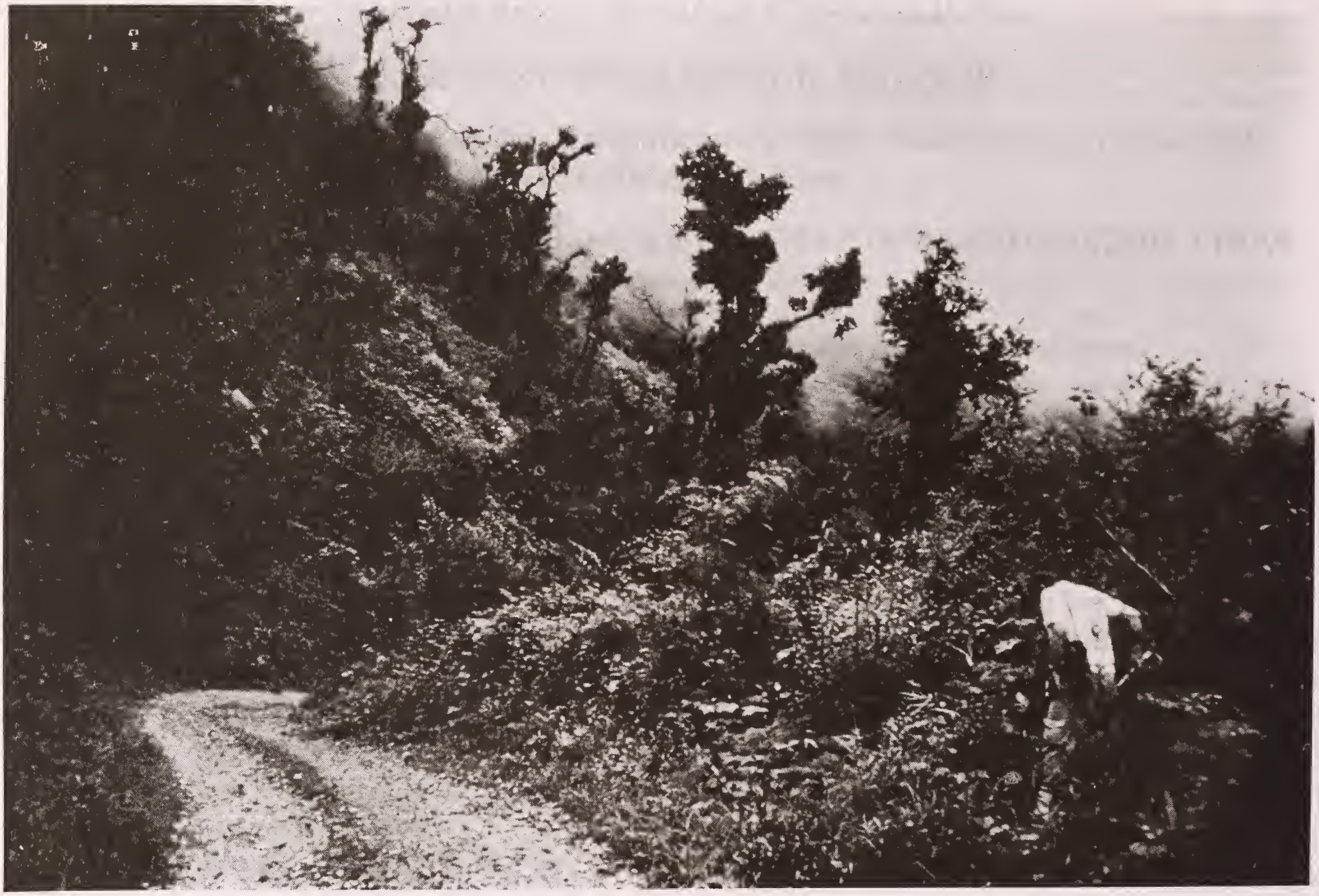


Fig. 2. Habitat of *Japalura tricarinata*.

tions can only be extrapolated from records in Kathmandu and the station at Godavari at the base of Phulchoki. It is characterized by summer, monsoon and dry winter. Usually temperatures vary between 20-30°C in summer and 0-18°C in winter. Monsoon occurs in summer between June and September when over 80% of the total precipitation falls. The annual amount recorded in Godawari at the base of Phulchoki (fig.1b) is 1863.5 mm, this is 42% higher than Kathmandu (1301.9 mm). Phulchoki is more humid and cooler than Kathmandu during all seasons. Frost occurs in winter from the lower parts on where it lasts for several weeks. Snowfall is common above 2300 m. The pre-monsoon season from March to May is mostly dry and warm, postmonsoon from September to November is sunny and mostly dry with a gradual decrease in rainfall and temperature.

In order to visualize the rain forest climate we tried to construct a climatogram (fig. 3) which is thought to present general climatic traits rather than exact data. As there are no registrations from the area the temperature curve for Kathmandu (elevation 1340 m) was lowered by 10°C, corresponding to the adiabatic temperature decrease of 1°C for 100 m of additional elevation. The fact that there is an occasional snow cover is in accord with the subzero temperatures in January. As for precipitations their general distribution was assumed to be similar to that of Kathmandu. Their amount was accepted to be like that of Godavari at the foot of Mount Phulchoki, i. e. 42% more than in Kathmandu. The precipitation curve was increased by that amount. Real values are certainly quite higher and in monsoon times there is a lot of fog and clouds.

In the graph, the temperature curve presents a crude measure for evaporation. Thus the difference of both curves (hatched area) represents the precipitation surplus which is very high during the monsoon months.

2.2. **Vegetation** (see habitat photo fig. 2): Mount Phulchoki is covered by mixed forests of broadleaved evergreens from 1500 to 1800 m and oak-laurel forest from 1800 to 2400 m. Above 2000 m there are some *Pinus* sp. scattered in the oak forest. A large portion of the forest below 2000 m is damaged or destroyed by human farming activities leaving only a few large trees. The slopes facing south are generally converted into terraced fields. The basal part of the Phulchoki region is covered by mixed vegetation with a large number of shrubs and small trees. The dominant species are: *Schima wallichii, Castanopsis indica, Alnus nepalensis, Ilex doniana, Zizyphus incurva, Leucoceptrum canum, Myrica esculenta, Rhododendron arboreum, Prinsepia utilis, Daphne papyracea, Rubus ellipticus, Rosa brunonii, Ligustrum nepalense* and *Eurya acuminata.* There are quite a few climbers and epiphytes towards the shady slopes of Phulchoki. Some of the common genera are *Rubia, Smilax, Cissampelos, Dioscorea, Clematis* and *Jasminum.* Epiphytic vegetation consists of orchids and ferns. Parasitic Loranthaceae grow on trees (Flora of Nepal and Godavari, p. 144).

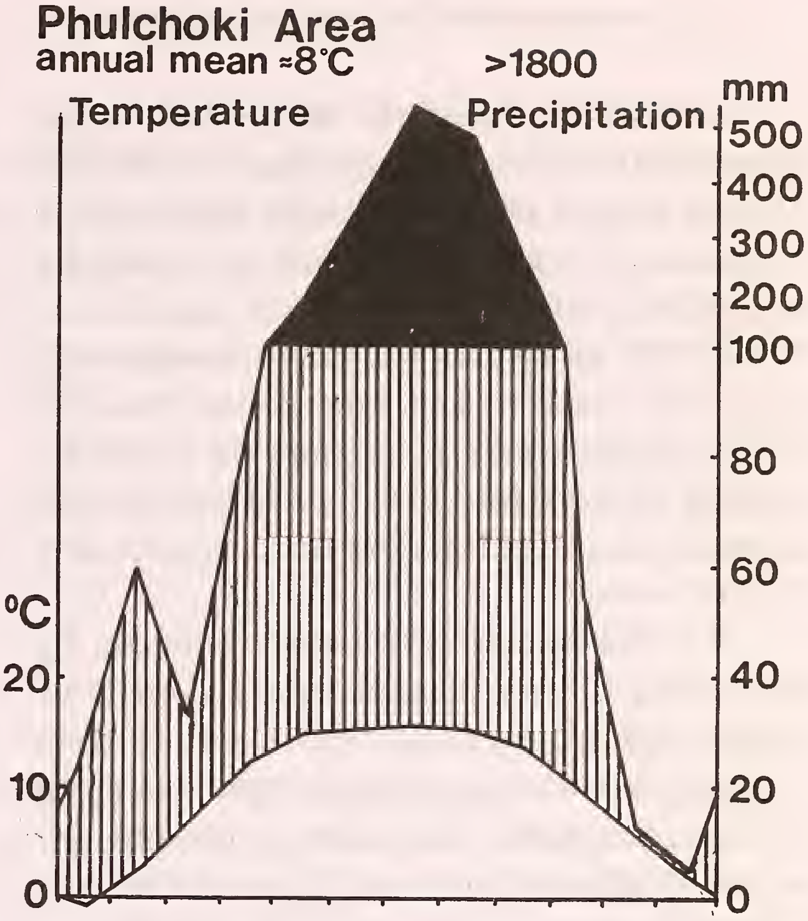


Fig. 3. Climatogram of the Phulchoki area.

2.3. **Fauna of Phulchoki:** No scientific study has been done hitherto but according to the reports of local people and birdwatchers there are more than 200 species of birds, more than 20 species of mammals and few species of amphibians and reptiles. Mammals observed by villagers are: Leopard (*Panthera pardus*), Jungle Cat (*Felis chaus*), Leopard Cat (*Prionailurus bengalensis*), Jackal (*Canis aureus*), Tibetan sand Fox (*Vulpes ferrilata*), Yellow throated Marten (*Martes flavigula*), Common Palm Civet (*Paradoxurus hermaphroditus*), Rhesus Monkey (*Macaca mulatta*), Common Langur (*Presbytis entellus*), Porcupine (*Hystriyx indica*), Barking Deer (*Muntiacus muntjak*) and many rodents. Sometimes Leopards take goats, pigs and dogs from the villages.

3. FIELD OBSERVATIONS ON *Japalura tricarinata*

On Mount Phulchoki the species occurs from 2000 to 2600 m and was found in 1989 and 1991. It lives in subtropical jungle which change into mountain rain forest. This zone is clouded over most of the year. Our last excursion took place on 16/07/1991 during fair (not rainy) weather with even some sunshine and temperatures from 25-28°C. *Japalura tricarinata* were discoverd by walking on an asphalted but little frequented road at an elevation of 2000 m along the forest edge from 13.50 h onwards.

The fleeing lizards betrayed themselves by the rustling of dead plant material and could be mostly captured by hand. Only a few of them escaped. They were not regularly distributed along the forest margin but occurred in groups with a few meters of individual distance. Three females, two subadult males and one juvenile but no adult males could be found this way. Probably the adult males were perched on branches and did not move when we passed by. Crossing the dense forest by a narrow path brought no success and we conclude that, at least in this area, *Japalura tricarinata* is limited to the favourable microclimatic conditions of forest margins exposed to sunshine.

During an earlier excursion on 23/06/1989 some females were still pregnant and shortly before oviposition while in July 1991 all of them were in nonreproductive state. The reason for the very good yield (14 specimens) of the June excursion was the better visibility caused by the scarcer vegetation.

4. OTHER RECORDS FOR *Japalura tricarinata* IN NEPAL

Other records for *Japalura tricarinata* in Nepal mainly made by K. B. Shah are:

– Ghorepani, western Nepal (Annapurna Conservation Area), 2790 m, coll. 1980.

– Shermathan, 2570 m, Helambu, Central Nepal, 1979, by verification through local inhabitants.

– Daman, Central Nepal, 2360 m, visited in July and August 1991 when 1 and 6 specimens were collected.

– Phulchoki, 2200 m. During forestry works done by local people a member of the excursion (K.B. Shah) found a clutch of eggs.

The material collected by H. Schleich *et al.* from Phulchoki is stored in the Zoological State Collection of Munich / F. R. Germany.

PART II. BEHAVIOUR PATTERNS IN *JAPALURA TRICARINATA* (BLYTH, 1853) AND *J. POLYGONATA (HALLOWELL, 1861)*, (SAURIA : AGAMIDAE)

(With two colour plates and twenty text-figures)

The behaviour patterns of captive *Japalura tricarinata* and *J. polygonata* are compared. Both are predominantly arboreal, ambush hunters and thermoconform. *J. polygonata* is more sedentary and its display consists chiefly in posturing while in *J. tricarinata* rhythmical bobs and pushups prevail. The appendix contains a list of behaviour patterns in *Japalura Swinhonis*, *polygonata*, and *tricarinata*.

INTRODUCTION

Diurnal arboreal lizards present themselves as ideal objects for the study of reptile behaviour, and the optical signals of Iguanidae have been intensely investigated (Greenberg and McLean, eds., 1978) while corresponding works on

Agamidae are much scarcer (Carpenter and Ferguson 1977; further references). Playing an important role in isolating mechanisms communicative behaviour, more than other act systems, changes during speciation. Here the genus *Japalura* offers a wide field for further observations.

Of the two species compared in this study. *J. polygonata* (Hallowell, 1861) is closely allied to the Taiwanese *J. swinhonis* Günther, 1864. Its range extends from northern Taiwan over the Ryu-Kyo Islands in their full extent of about 800 km from Irimoto Island (Irimoto-Shima) in the south to Amani Island (Amani-O-Shima) in the north. Three subpecies are recognized (Ota 1991): *Japalura polygonata polygonata* (greatest part of Ryukyu Islands); *J. p. ishigakiensis* Van Denburgh, 1912 (Yaeyama group, southern Ryukyu Islands); *J. p. xanthostoma* Ota, 1991 (lowlands of northern Taiwan).

Our second species *Japalura tricarinata* (Blyth, 1853) from the Kathmandu valley, Nepal, is a very distinct form concerning range and systematics. In contrast to *J. polygonata* its generic name has changed several times since its description : *Calotes tricarinata* Blyth, 1854; *Tiaris ellioti* Günther, 1860; *Oriotiaris tricarinata* Anderson, 1871; *Charasia tricarinata* Stoliczka, 1872; *Acanthosaura tricarinata* Boulenger, 1888. The northern limit of *J. polygonata* approximatively coincides with the geographic latitude in which *J. tricarinata* lives.

We are grateful to Mrs. Wenyu Wu, Inst. of Paleontology, Academia Sinica, Beijing, for kindly translating the article by Wei & Lin (1981) from Chinese. She made a wealth of ethological observations available for interspecific comparison.

MATERIAL AND METHODS

Our observations on *J. polygonata* and *J. tricarinata* are fragmentary as both species were observed in captivity from August to October (postbreeding season) in 1990 and 1991 respectively. We had four *J. p. polygonata* males from the animal trade without exact data on provenience.

From *J. tricarinata*, six adult females and two subadult males, were caught on 16/07/1991 in the mountain forest of Phulchoki at a height of 2300 m (see part I of this paper).

Both species were kept in a greenhouse 2 x 3.5 m planted with evergreen oaks, ferns and vines. The northern wall entirely and the southern and western sides up to the height of one meter are covered with rocks. The local climate at the northern border of the Bavarian Alps with the greenhouse facing south offered appropriate keeping conditions with a daily sprinkling and an automatic aeration. In October some additional heating with a 60 W spot lamp was provided on rainy days.

During the observation months the animals were checked at least every daytime hour. A record was kept on locomotions. If social interactions were going on the lizards were observed over several hours. Our aim was to describe and compare the behaviour systems of both species.

BEHAVIOUR PATTERNS OF *Japalura tricarinata* AND *J. polygonata*

1. BASIC SPATIO-TEMPORAL BEHAVIOUR

1.1. Daily activity phases: Both species are strictly diurnal and spend most of their active phases sitting and observing the surroundings.

The transition between sleep to intense activity will be described later (2.7).

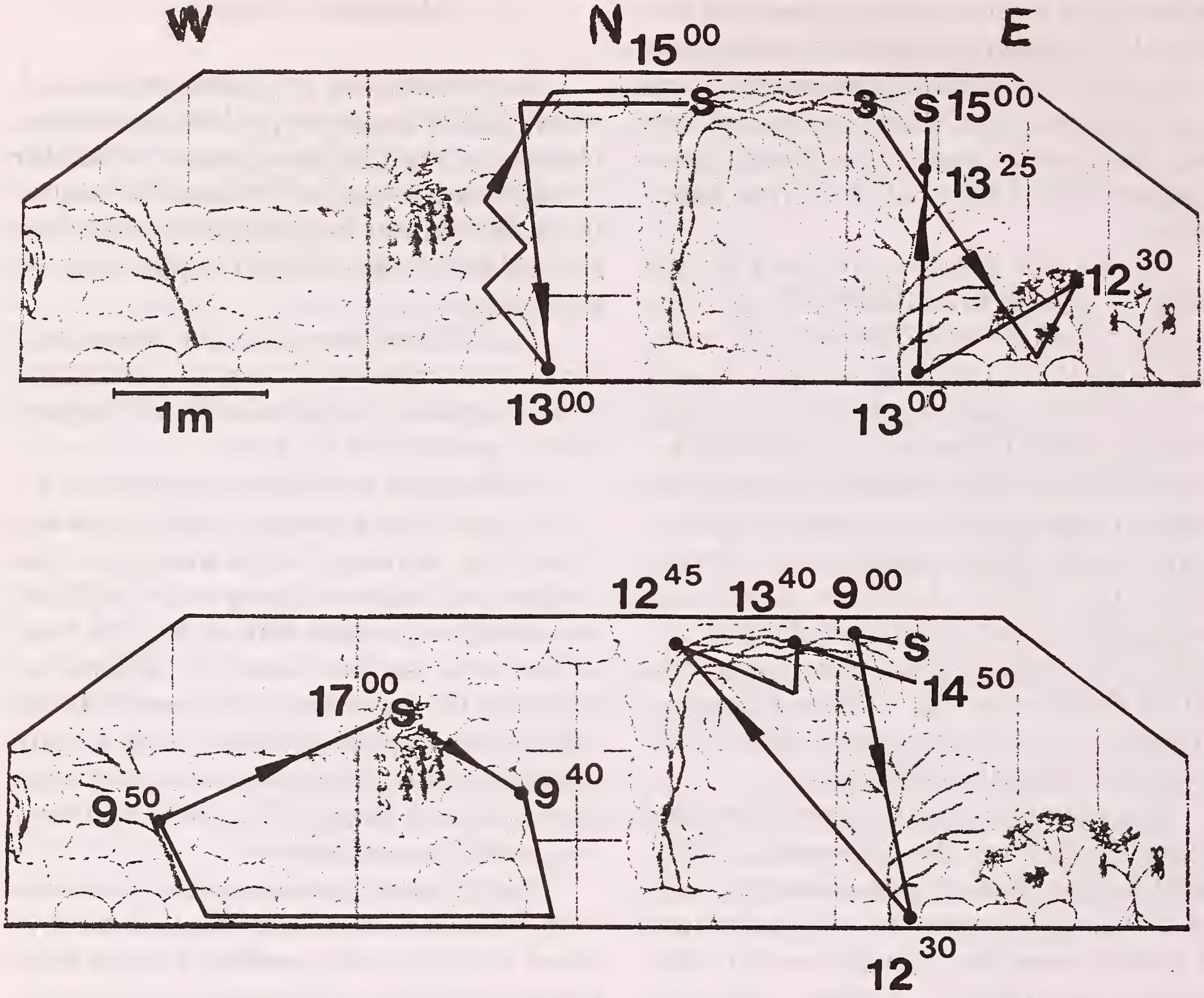


Fig. 1. Examples of daily excursions of *J. polygonata* males which returned to or close to former resting sites.

Phases of locomotion can be observed in connection with feeding, thermal behaviour, social encounters and investigation during which the animals were running on the ground or on the stone wall. As fig. 1 shows phases of locomotory activity are short. Compared with natural conditions the locomotory level was probably higher because the animals lived under relatively cramped conditions. According to Lin and Lu (1982) the mean home range of a *Japalura swinhonis* male is 33.47 m with a mean dispersal distance of 8.8 m. We assume that the values for *J. polygonata* and *J. tricarinata* lie in the same order of magnitude and that the animals in the greenhouse were under social stress. Often one or two of them tried to escape through the lateral window.

Temporal sequence of activity levels: As there are no fundamental differences between the two species, they can be treated together. Be-

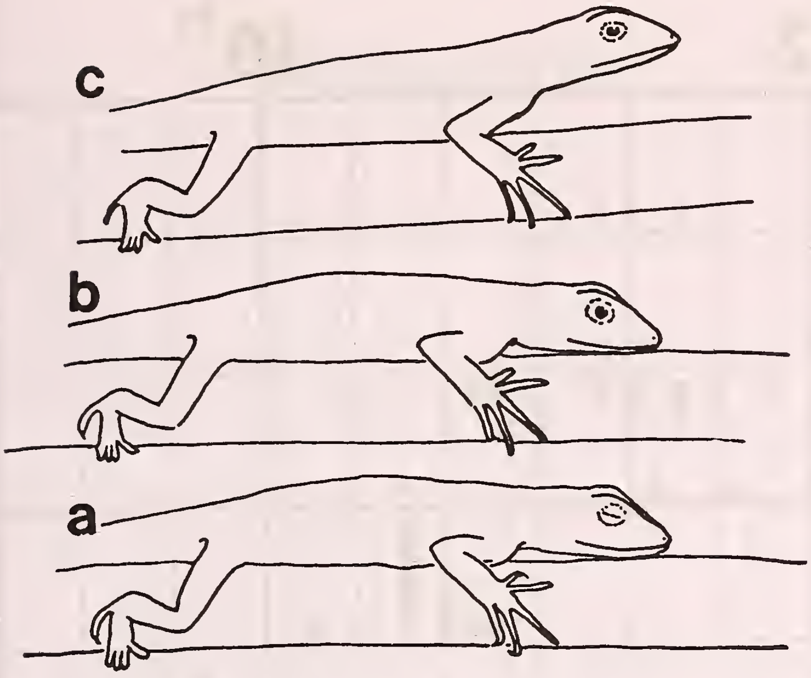


Fig. 2. Obligatory activity levels in *J. tricarinata:* a: sleep, b: eyes open, c. alert.

tween sleep and high locomotory activity there are several intermediate stages mostly connected with the circadian rhythm. Crudely simplifying we classify them as states a to f, beginning with the lowest one. The levels a to c (fig. 2) are called "obligatory", because they are attained daily by every healthy animal. They exclude any locomotion and are bound to the sleeping position. In the levels d to f the lizards leave this place. These stages are facultative. During bad weather and in low-ranked animals they lack or are much reduced. But even high-ranked *J. polygonata* may insert a "resting day" during a period of fair weather.

In fig. 3 observations on both species during August and the first ten days of September are plotted but not directly comparable because four *J. polygonata* males stand against six *J. tricarinata* females. The two males of the latter species were omitted because of their bad state of health. During the observation periods days were from one up to over two hours longer than in the natural surroundings. In the right half of the diagrams representing afternoon the transit from full activity to sleep is also stepwise but inverse. The generalized drawings in fig. 2 apply to both species.

Obligatory activity levels: a. Sleep in appropriate elevated position, head on substrate, eyes closed. b. Eyes open but no observatory motions, which are very evident in *J. polygonata.* Position and posture as in a. c. Full alertness. The animals normally lift their heads somewhat above the substrate. Searching eye motions start.

Facultative levels which include locomotion: d. Leaving sleeping position but remain in its vicinity. In shrubs the animals climb some 10 to 20 cm upwards. e. Moving farther away from the sleeping position, e.g. jumping on the ground. f. Prolonged and intense locomotion, jumping, running and climbing often connected with investigatory behaviour.

The diagram fig. 3 shows that the "attachment" of *J. tricarinata* to its sleeping sites at low temperatures is less intensive than in *J. polygonata.* Tanaka (1986) observed activity from 7.00 to 19.00 h in July and October at air temperatures between 24° and 30° C.

1.2. **Annual activity change**: It occurred in both species but was of different intensity.

J. polygonata: Until the beginning of October locomotory activities covered the whole extent of the greenhouse. Rather abruptly all animals adopted the resting state by October 6th and but rarely interrupted later. In sharp contrast to *J. tricarinata* all of them stayed in the open at their normal sleeping sites and continued feeding. Like *J. tricarinata* this species creeps into crevices but apparently stays there only under unfavourable weather conditions. Tanaka (1986) found active *J. p. ishigakiensis* even in December. According to Lin & Lu (1982) the closely related *J. swinhonis "formosensis"* hides during rain (one *J. tricarinata* hid from spraying) and

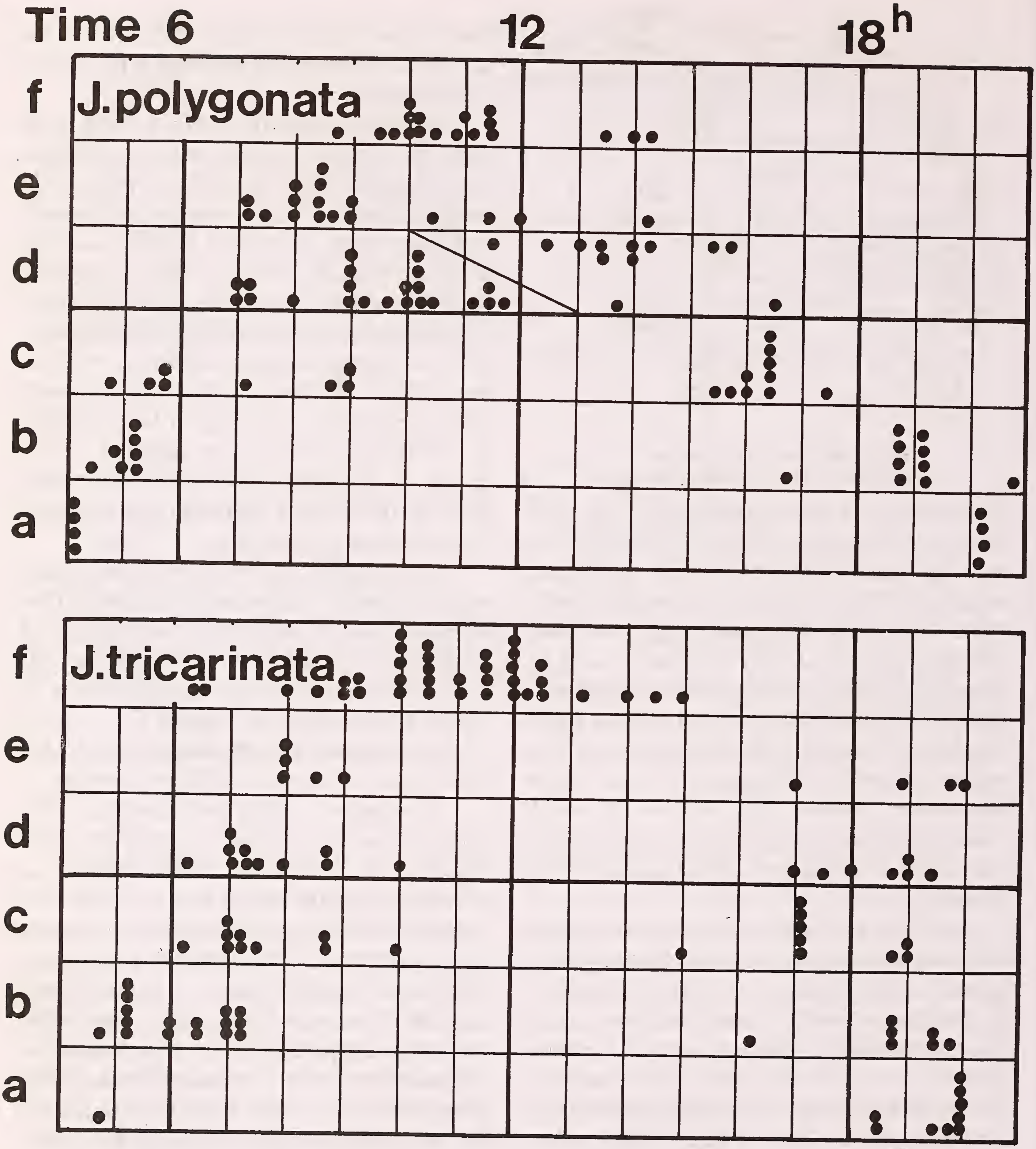


Fig. 3. Temporal sequence of activity levels in *J. polygonata* and *J. tricarinata:* a. sleep, b. sleeping posture, eyes open, c. fully alert, d. leaving sleeping position, e. moving over greater distance, f. intense locomotion.

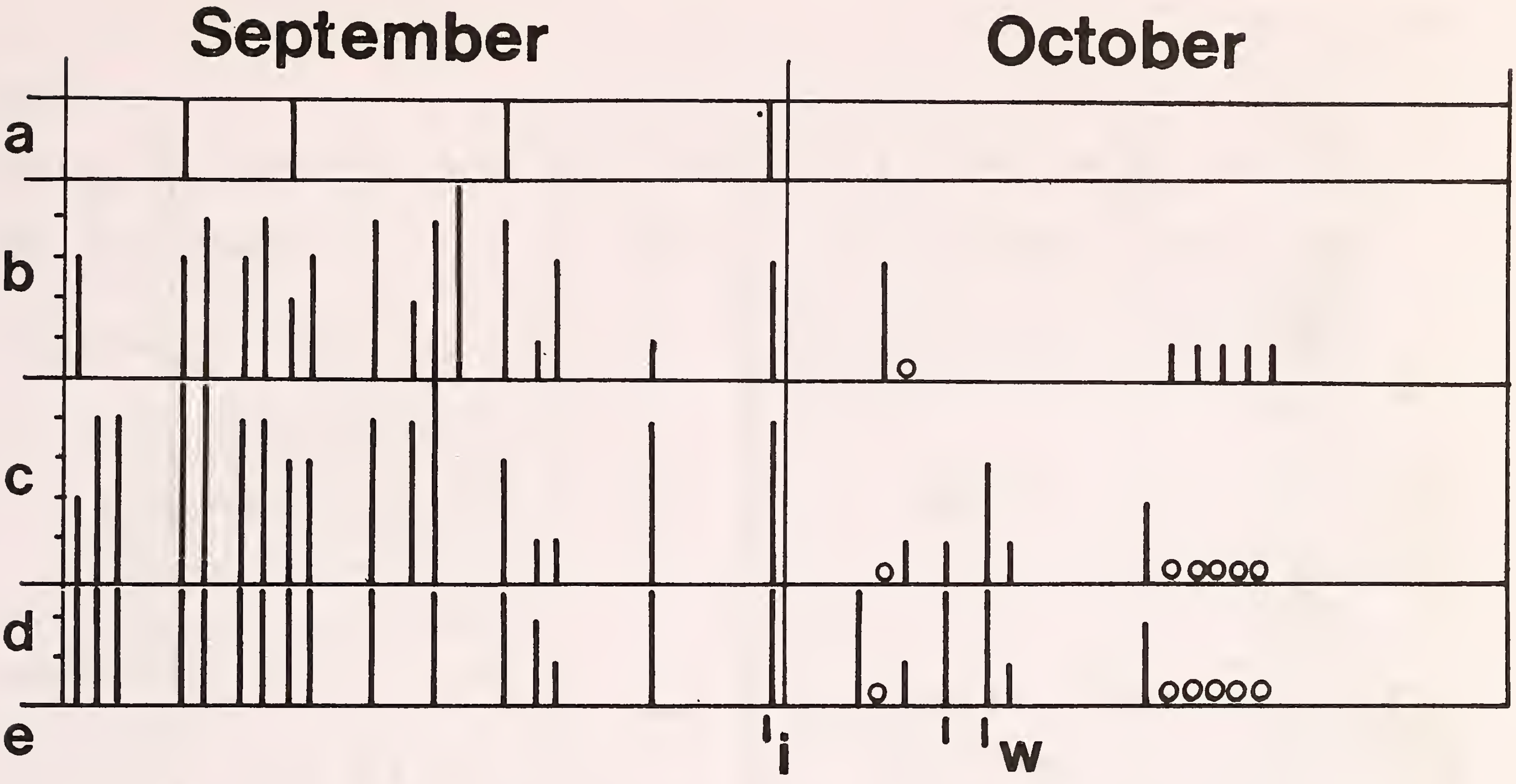


Fig. 4. Behavioural changes in five *J. tricarinata* females towards the end of summer, a. inspection of cavities, b. number of animals sleeping open in plants, c. number of active animals (not resting) during sunny weather (1-5). d. highest activity level observed that day, 1. slight shift of position, 2. basking, 3. running around , e. feeding, i. intense, w. week, 0. zero values.

hibernates from November to February, but emerges on warm winter days.

J. tricarinata: Striking behavioural changes occurred towards the end of summer. As the alternations took place during a period of sunny weather sinking temperatures cannot be assumed as a causative factor. Possibly decreasing day-length timed an internal clock.

During September the lizards were seen many times inspecting holes in the stone walls, trying to creep into them, even if they were very narrow (fig. 4a). In the following weeks the number of animals sleeping on branches decreased (fig. 4b). Often they spent the nights in cavities and could be seen creeping out of them in the morning. The number of active animals which left their resting sites on branches or in holes, even during sunny days, diminished (fig. 4c). After the first ten days of October no more lizards could be seen running around on the ground or on walls but they still basked. At the same time food intake stopped (fig. 4e).

During the following winter months the minimal air temperature in the greenhouse was kept at 7°C. After hibernation the first lizard reappeared on February 27th after more than four months of inactivity in an excellent state of nutrition and started drinking and feeding at once.

One female spent the winter hidden between leaves. She changed her position several times but did not move farther than a few centimeters.

The unfavourable weather conditions with dry and cold winter monsoons from Central Asia

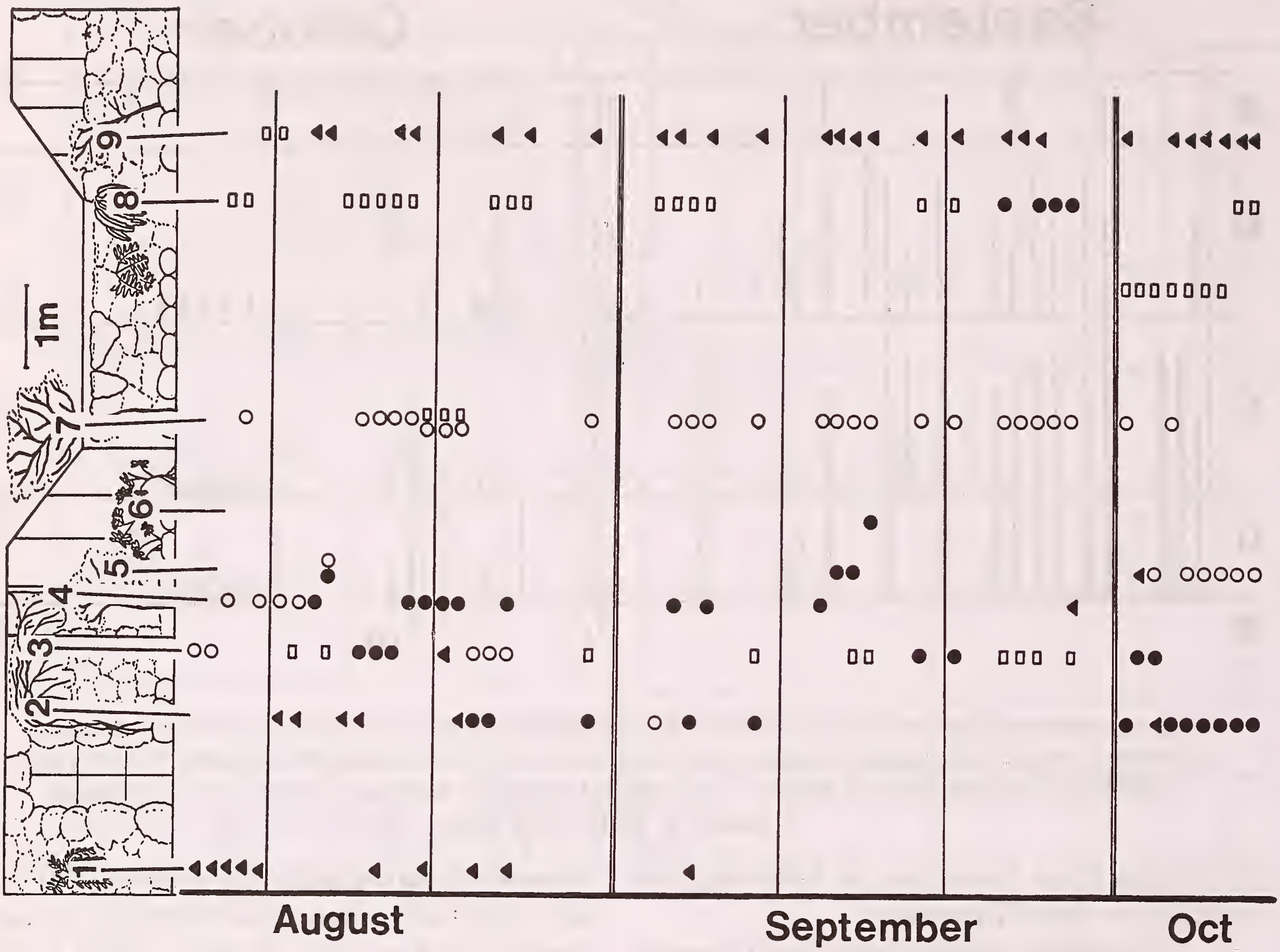


Fig. 5. Resting places of *J. polygonata.*

suggest that *Japalura tricarinata,* at least at higher elevations, hibernates several months.

1.3. **Activity range and spacing:** *J. polygonata*: As already mentioned the base of our greenhouse would have to be at least tripled to offer the natural home range of one male (comparable with *J. swinhonis*). Even under the present dramatic compression the males managed to divide the disposable space among them without despotism. This is evident for sleeping places (fig. 5) which were accepted after three days and from there on used continually by one of the animals, rarely two of them.

J. tricarinata: The activity ranges of males and females in the glasshouse greatly differed. Most animals slept high up in bushes and vines (fig.6) but during locomotory activities the females very frequently moved on the ground or walls while males spent most of their time in the foliage. Among females activity ranges greatly differed between high and low ranked animals. One female moved about all over the greehouse (it slept in the highest oak-bush) while another one scarcely moved more than 40 cm off her resting place, a fern at the right end of the south side wall. The resting sites chosen were very

	male ○ (resident)	male □ (aggressor)
20.08.1990		
7.00	Sites and patterns of both males as yesterday evening.	
8.15	Climbs higher into the leaves.	No change.
10.00	Jumps to the ground.	Advertizes for 20 minutes.
10.30	Sits on low plant.	Sits exactly on the resting place of his rival; green with darker spots, lateral line light green.
13.50	On lower end of rope.	Same place; becomes dark brown; accelerated respiration (every 1.2 sec.), eyes half closed.
15.30	Returns to the oak stem; black with yellow lateral stripe.	No change.
17.55	Climbs into the foliage and sits. 7 cm opposite his rival; black with somewhat lighter lateral stripe (pl. 1, 4).	Becomes black.
19.00	Climbs higher and rests in the foliage 20 cm over his rival.	No change.
20.50	No change.	Turns round.
21.08.1990		
7.40	Sites as yesterday evening; both males dark olive green with dark yellow lateral stripes advertizes.	
8.00	Climbs some cm higher, continues advertising.	Climbs towards the stem.
9.10	Jumps out of foliage, sits on rock wall.	No change.
9.30	Climbs higher on the wall; turns olive green with yellow stripe.	Turns brown with olive stripe.
13.30	Sits on the wall looking atis rival.	No change.
14.15	Jumps back into the foliage and sits 25 cm from his rival.	No change.
14.55	Sits on the oak, tries to get through the window, fall son the ground.	No change.
17.20	Returns to his old transversal branch 25 cm from his rival.	No change.
	Both males become green	
18.25	Lies on his old branch.	Sits 10 cm above him.
22.08.1990		
7.00	Sites and patterns of both animals as yesterday evening.	
8.30	Sits still high up-in the oak; dark green with olive yellow lateral stripe.	Has disappeared.

	male ○ (resident)	male □ (aggressor)
9.25	Tries to get through the window and falls on the ground; brownish green with dark olive stripe.	
9.45	Sits on his oak again.	
12.12	Runs around in the greenhouse.	
12.30	On low plants.	Returns to his old residence in the fern; feeds without hesitation; dark olive, lateral stripe olive yellowish. General turbulence in the greenhouse; the other two males which did not take part in the dispute run arolund and try to get out of the windows.
15.00	Climbs into the Jasminum vines and returns into the oak on Aug. 24th, and dwells there, with short interruptions until Oct. 9th.	Dwells in his fern until end of observation on Oct. 9th.

Remarks: Nearly all social interactions of lizards documented in literature belong to the relatively "rapid" type lasting minutes, rarely hours. The supplanting described above greatly differs from this scheme and offers a series of unfamiliar aspects worth mentioning:

1. The interaction lasts four days with the animals sitting motionless for most of the time.

2. No intense levels of signalling including threat behaviour are applied.

3. The animals interact far into the evening during their normal resting time.

4. The supplanting male enters his rival's territory and "besieges" him, scarcely moving from the spot for two days.

5. The besieged male clings tenaceously to his oak. He leaves it on the second day but returns several hours later. During the third day he leaves and returns twice.

6. The besieger shows signs of heavy stress (20.8.1990 at 13.50h) three hours after his adversary has left.

7. The two-male interaction ends in a general turbulence seizing all four males in the glasshouse. They obviously observe each other steadily. Another striking effect is that the successful defender, after getting rid of the intruder, leaves his oak and returns but two days later. In the meantime another male (number 1) resides there.

8. The loser takes it easy. He was not chased and feeds at once after his return.

9. The correlation of colour patterns with definite situations is rather loose. A dark brown to black colouring marks critical situations with the rivals at close distance. As none of them showed these hues during the last two days of the interaction it might be concluded that they were both tired of the quarrel and left the oak.

In *J. tricarinata* only adult females interacted, but almost all encounters occurred at a low level without any threat posturing. Only once the inferior female received a short bite in the leg but normally the mere sight of the dominant female at close distance (20 cm) was sufficient to release flight.

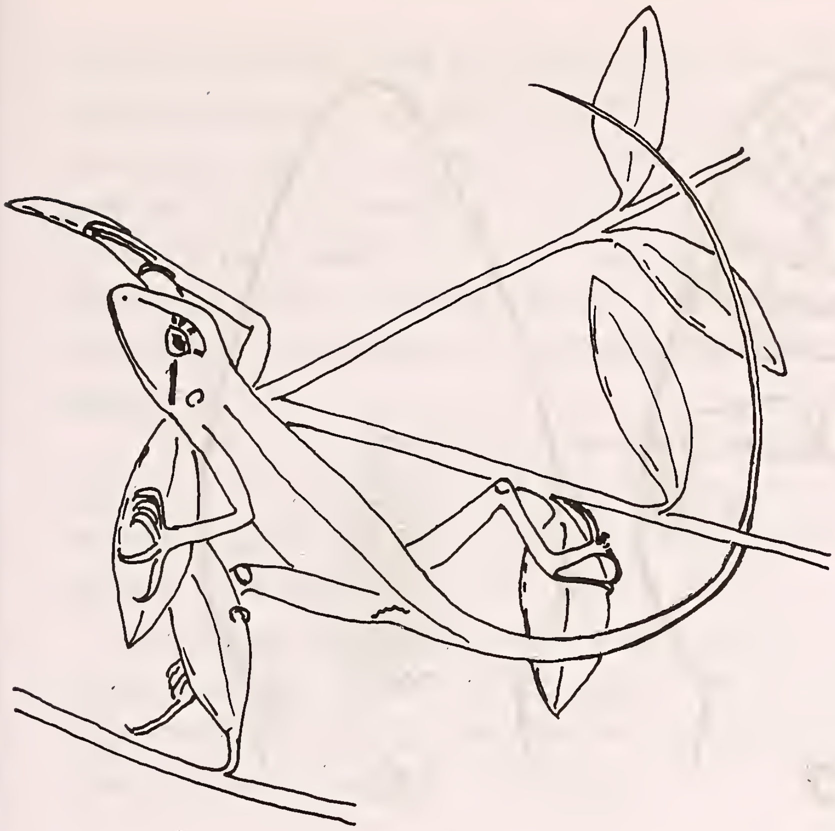


Fig. 19. *J. tricarinata*, subadult male, resting posture.

The fleeing animal was never persecuted. In mirror experiments the females either did not react to their image, turned off or fled. The reaction was released rather slowly, from 20 sec to 3 min. Even if the lizards did not move their respiration frequency rose, e.g. from 60 flat to 84 deep motions per min. Flight could sometimes be released by moving the mirror.

Similarly during interspecific reaction a resting conspecific did not release flight until it moved.

5. ANTIPREDATOR MECHANISMS

5.1. Cryptic mechanisms: Colour patterns, postures and substrate choice interact to create a cryptic effect which is perhaps most effective in *J. tricarinata* males. Two disruptive pattern elements are common to both species and enhance the cryptic effect of colouring: the elbow and knee spots and the thigh pit. The spot interrupts the leg shape and looks like the broken end of a twig. It is optically enhanced by a dark border. The thigh pit is a flat pocket at the proximal upper end of the upper thigh (pls.1,5; 2,1&6) and differs from its surrounding in much smaller scale size and brown colouring. Its function may also be a mite pocket.

As to the substrate choice the segregation of *J. tricarinata* females and males attains a considerable degree and possibly entails an antipredator effect. Field and captivity observations affirm that the green males do not only occupy a higher stratum of vegetation but – at least the younger specimens – hide among leaves while the females rest on branches. As the sexes differ in colour, substrate and posture, an optically oriented predator has to master two rather different prey schemata.

Resting *J. tricarinata* males (fig. 19) are almost indetectable for the human eye, even at close distance. In the greenhouse the two males most time resided in the crown of a small oak bush (number 7 in fig. 5) with a diameter of 50 cm. In this small space they usually were found but after long minutes of search. Often their tails were discovered first because they did not fit into the array of leaves and twigs. A simple way of getting them to move was to spray the foliage with water.

Another form of cryptic behaviour was observed when ants crept across the head of a *J. polygonata* eyes. They did not release hindleg scratching but closing of eyes which is probably not perceivable by a watching predator.

5.2 Escape behaviour: Frightened *J. polygonata* jump to the ground, even from heights of two metres, and try to escape running and jumping alternately. During a very low intensity fleeing reaction a male crept backward from the approaching hand.

In the field *J. tricarinata* females sitting on the ground regularly betrayed themselves by a

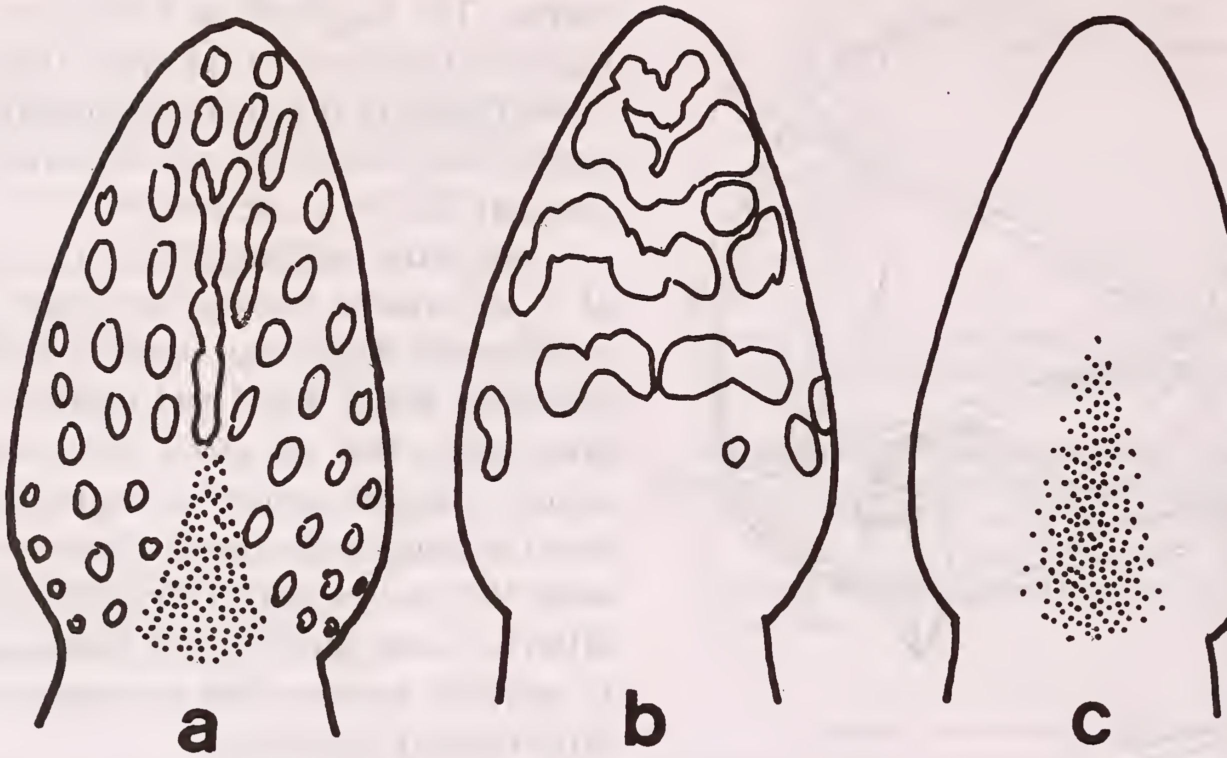


Fig. 20. Optical signals on gular regions of a. *J. polygonata xanthostoma*, b. *J. winhonis*, c. *J. p. polygonata*. The dotted region is orange.

rustling noise when they fled over dead leaves while the males sitting among leaves remained motionless. The fleeing distance for females was about two metres. As there were no males discovered sitting on the ground it could not be tested if the different fleeing behaviour depends on sex or surroundings.

In the greenhouse both species showed no fear from humans, took insects from pincers, tolerated close-up photographs and even climbed on the hand.

Experiments with "predator" dummies can release very vehement reactions in *J. polygonata* and therefore were performed but a few times. A five centimetres long plastic toy saurian was mounted on a stick and approached towards the resting *Japalura*. The young male reacted only with substrate-licking. An adult male at once jumped 20 cm away, climbed down from his perch while his colour changed to dark green and hid crouched behind the stem for two hours. After this he turned light green, jumped to the ground and tried for three hours to get through the glass wall. Later he did not return to his normal sleeping place.

5.3. **Defense behaviour:** When handled after capture *J. polygonata* males threaten with extended gular sac gaping at a 10 cm distant finger and bite vehemently (*J. tricarinata* never did) if it comes to close. They take a firm hold, even for half a minute, but their tiny teeth do not pierce the skin.

On one occasion a handled *J. polygonata* emitted four short peeping cries, each about 1 sec long. Vocalization was also heard when a recently caught *J. tricarinata* was handled.

6. DISCUSSION

We take the article of Wei and Lin (1981) on *Japalura swinhonis*, closely related to *J. polygonata*, as reference base for a comparison. Many fixed action patterns are identical or can be easily homologized (see appendix). As we could not observe rival behaviour between our *J. tricarinata* males nor any courtship a comparison with the flow diagrams in Wei and Lin (1981) is impossible. But even our incomplete observations show that the communicative systems of the three species diverge remarkably in some points.

Optical colour signals presented during gular extension and gape of threatening Japalura are different (fig.20, pl.1,2; data on *J. swinhonis* and *J. p. xanthostoma* by Ota, 1988 & 1991).

J. swinhonis: throat without a central yellow or orange marking; chin and gular region with large white roundish spots in transverse or semicircular rows; palatal mucosa grey or dark grey.

J. makii & *J. brevipes*, Taiwan highlands: throat without a central yellow or orange marking palatal mucosa dark gray or black.

J. polygonata: yellow or orange marking in the middle of the throat; *J. p. polygonata:* chin and gular region without white marking; palatal mucosa pink; *J. p. xanthostoma*: palatal mucosa yellow or yellowish pink; ventral surface of head with obliquely arranged small white spots.

J. tricarinata: the whole gular region is white (with tiny black spots in some) and its colour is without importance for signalling. No gular extension and gape could be observed.

After Wei and Lin (1981) threat display in *J. swinhonis* comprises series of head-bobs as well as signature display. In *J. polygonata* the only act

APPENDIX

STEREOTYPED BEHAVIOURAL PATTERNS IN *JAPALURA SWINHONIS*, *POLYGONATA* AND *TRICARINATA* (NUMBERS AFTER CARPENTER & FERGUSON, 1977; DATA ON *J. SWINHONIS* AFTER WEI & LIN 1981)

	Behaviour	*swinhonis*	*polygonata*	*tricarinata*
1.	aggression	+	+	+
2.	dominance	+	+	+
3.	dominance shift		+	
4.	supplanting	+	+	
5.	threat and defence	+	+	+
6.	gape	+	+	
8.	fight	+		
9.	lunge	+		+
16.	leg bite	+		+
17.	tail bite	+		
19.	chase	+		+
21.	straddle	+		
33.	aggressive display	+		+
34.	challenge display	+		
35.	assertion display	+	+	+
36.	species-specific display	+		+ (signature bob)
38.	display site selection	+	+	
40.	posture	+	+	+
41.	high stand	+	+	
43.	front leg rise	+	+	+
44.	raise head		+	

	Behaviour	*swinhonis*	*polygonata*	*tricarinata*
45.	four-legged raise	+	+	
50.	compress laterally	+	+	
58.	inflate throat	+	+	
62.	protude tongue	+	+	
64.	lick (substrate)	+	+	+
65.	erect roach	+	+	
66.	lateral presentation	+	+	
67.	face off	+		
69.	circling	+		
73.	pushup	+	+	+
75.	head bob	+		
80.	display jump (lateral)	+		
95.	tail wave	+		
98.	courtship	+		
116.	female rejection behaviour	+		
119.	limp female	+		
126.	leg hold	+		
129.	neck bite hold	+		
134.	drag	+		
138.	submissive behaviour	+		
139.	flatten	+		
140.	eye closed		+	
141.	leg spread	+		
147.	flight	+	+	+
149.	catalepsy	+	+	+ males
153.	brooding behaviour	+		
154.	vocal behaviour		+	+
155.	colour change	+	+	+
158.	social behaviour	+	+	+
Addition				
	observational behaviour		+	+
	basking posture	+		
	defecation posture	+	+	+
	wipe snout on substrate			+
	scratch body with hind leg			+
	bathing			+
	resting (eyes open)	+	+	+
	select sleeping site	+	+	+
	sleeping posture	+	+	+
	alertness posture	+	+	+
	dig nest	+		
	push eggs	+		
	hide	+	+	+

comparable with them are single pushups (fig.15) which strongly suggest a relictary character.

A similar reduction in display motions exists in advertizing, where *J. swinhonis* in addition to posturing performs a typical signature bob which apparently lacks in *J. polygonata.*

Another example of signal scarcity in *J. polygonata* is the rival encounter described in supplanting behaviour where almost no displays were used.

Vocalisation during antipredator behaviour seems rare but was heard from both our species. Probably it does not lack in other related Agamids.

In *Japalura tricarinata* another shift in display evolution is evident: in females signature display is frequent (it lacks in *J. swinhonis*) and males, at least young ones, have a different signature pattern.

Several questions of major interest remain open. It is still unknown if other *Japalura* species defend their clutch sites as *J. swinhonis* does (Wei and Lin 1981). A study of habitat partitioning among males and females of *J. tricarinata* would also be promising. Its implications with feeding, fleeing and display behaviour are still unknown.

PART III. SEM-STUDIES ON SKIN AND EGGSHELL STRUCTURES OF *JAPALURA TRICARINATA* (SAURIA: AGAMIDAE)

(*With five plates and two text-figures*)

SEM-photos show that in this species the alveolar or honeycomb pattern of scale surfaces is very widespread. There is a great variety in bristled tactile buds distributed widely over the whole body surface while bristleless ones were only found in the mental region. The arrangement of the mainly fibrillar shell structural elements is described. During several expeditions in 1989 and 1991 one of the authors (Schleich) had the opportunity to collect *Japalura tricarinata* in the vicinity of Kathmandu, Nepal, providing material for studies on this species. In previous works (Schleich and Kästle 1979, 1982, 1988) we have covered similar aspects in other reptiles.

1. **Epidermal structures** (fig. 1; pls.1-4). In contrast to our previous studies, which centered on adaptations for climbing, SEM photos were also taken from different head and body regions.

1.1. **Head** (pls. 1 & 2): In accordance with the manyfold differentiations of head regions the greatest diversity of scale structures were found here.

1.1.1. **Pileus** (pl. 1, figs. 1, 2): The weakly keeled scutes bear tactile buds in their rear halves. The association of these organs with edges is also evident in other body regions. The bristle is pointed, oval in cross section, and emerges scarcely from its groove. The honeycomb pattern of the surface keratin layer descends somewhat into the cavity.

1.1.2. **Eye region** (pl.1, figs. 3-7): The eyelid is differentiated into several functional regions with typical scales. Each lid bears a longitudinal ridge of thick scales on its edge. They carry one or two bristled tactile buds in rather shallow depressions. Each of these scales flattens into a thin elastic sheet towards the lid slit which allows a tight closure. A part of this free rim is not organized into scales. The gross lid surface consists of gibbous polygonal scales.

The canthal scutes of the supraciliar region carry tactile buds with extremely long bristles. Where these scutes reduce their honeycomb pattern the structure becomes alveolar with smaller depressions and larger interstices.

1.1.3. **Snout tip** (pl.1, fig. 8): The tendency towards smoothness is still more accentuated.

1.1.4. **Labials** (pl. 2, figs.1, 2): Supra- and infralabials as well as most adjacent shields carry tactile buds with rather short spikes.

1.1.5. **Mental region** (pl. 2, figs. 3,4): The more exposed surface of the mental shield on the right and the following gular ones are smooth and carry series of round patches which can be supposed to be bristleless tactile buds (for internal structure see von Düring and Miller (1979). Their keratinous structure consists of a superficially flattened pillar which is countersunk into a sharply cut hole.

1. 2. **Hand** (pls. 2 & 3): The rigidity of the keratinous armour must be compensated by a complex array of hinged mobile elements which allow to combine free mobility, a firm grip and tactile functions. Here we find a multitude of different scales in close vicinity.

1.2.1. **Palmar scalation** (pl. 2, figs. 5-8:) The most striking feature are the very solid mucros which emerge from their upper surfaces some distance behind the tip. Thus, even if the palm is bent, these spikes cannot be pressed into the skin but rise somewhat above it, providing resistance from gliding off and guaranteeing a firm grip. The scale surface in pl.2, fig.8 is about to disintegrate, partially breaking up along the alveolar walls.

1.2.2. **Scales on lower side of fingers** (pl. 2, fig. 5, pl. 3, figs. 1-5): The view from below (plate 3, fig.1) presents mainly bicarinate scales which gradually change their shapes towards the distal ends. Here they resemble parts of hollow cones piled into each other and permitting a downward mobility while the dorsal sides are covered with simple flat scales. A more oblique view (pl. 3, fig. 2) reveals that the borders are emarginated in a peculiar way. When the finger is bent the keels enter into the emarginations of the more proximal scale so that a stronger flection is possible.

Tactile buds are evidently lacking in the bicarinate scales but occur regularly on the rims of the monocarinate lateral ones (pl. 3, fig. 5).

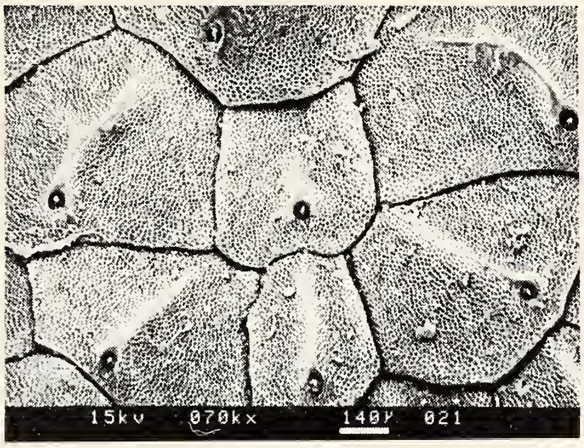
1.3. **Tail** (pl. 3, figs. 6-8): While the tail tip scales are devoid of tactile buds these are present on most (or all?) of the folllowing ones.

1.4. **Body scalation** (pl.4): As a homogeneous scalation is considered more primitive *Japalura tricarinata* presents a greatly derived state. But this change chiefly affects the dorsal region while the ventral one remained totally regular.

1.4.1. **Ventral scales** (pl. 4, figs. 1, 2): At the first glance the scalation looks very similar to the dorsal one of an *Agama* (e.g. *A. agama*). It is rhomboid, distinctly carinate and mucronate and arranged in perfect longitudinal and oblique rows. While the dorsal scales of *Agama* bear several tactile buds on their lateral borders we find them here at the scale tips. These present a series of peculiarities (pl.3, fig.2): The bristle is very long and distinctly flattened, nearly rectangular in cross section at its base. It extends over the keel of the next scale. The detail photo shows a mucro which is somewhat turned to the side, but this is rather the exception. The honeycomb pattern is restricted to the free scale borders.

1.4.2. **Ventrolateral scales** (pl. 4, figs. 3, 4): They are irregular in size, direction and distinctiveness of keels and, in contrast to the ventral ones, bear the honeycomb pattern. Tactile buds are apical but they occur only on scales with sharp keels. On pl.4, fig.4 one of the scales apparently did not moult. Its tip rests on the exposed rounded base of the next scale.

1.4.3. **Dorsolateral scales** (pl. 4, figs. 5-8): The row of keeled scales in pl. 4, fig. 5 is the left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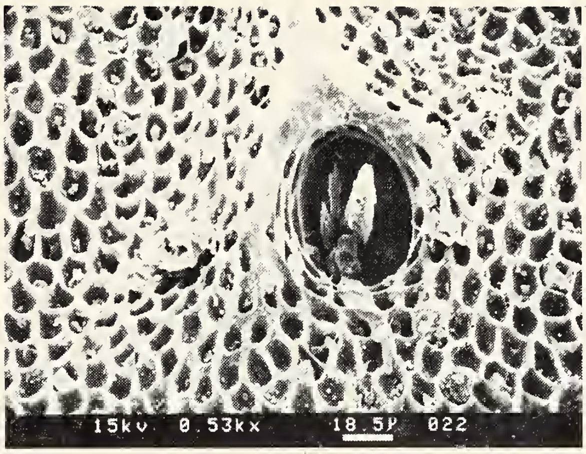
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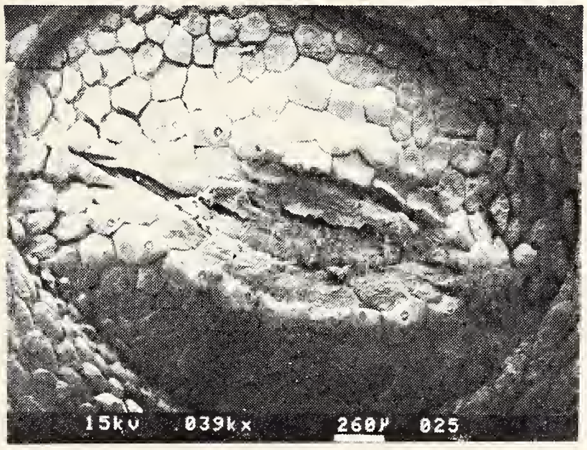
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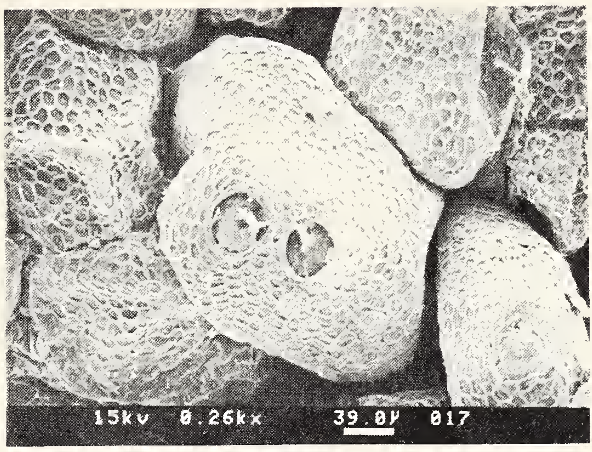
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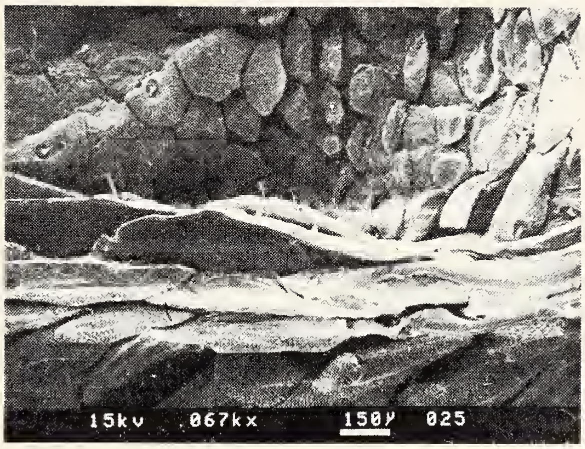
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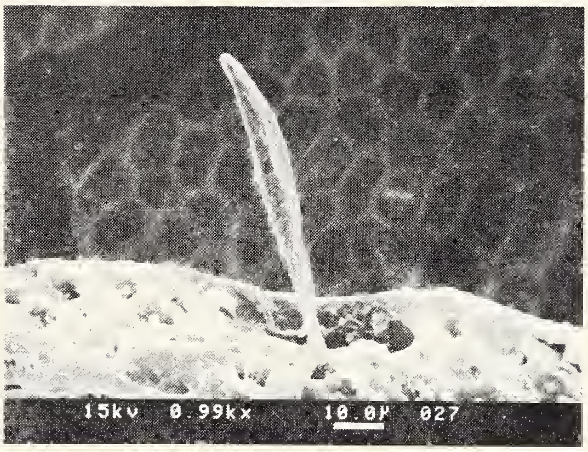
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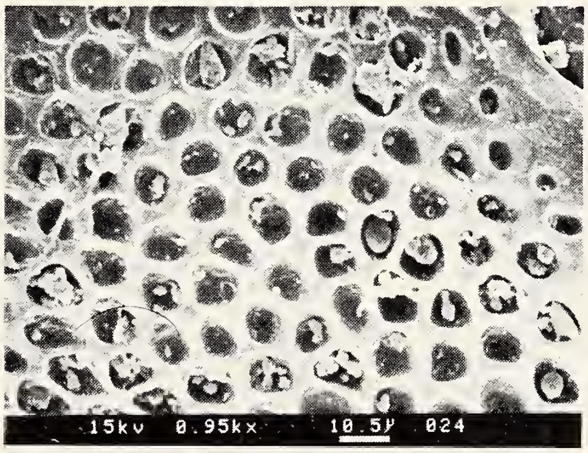
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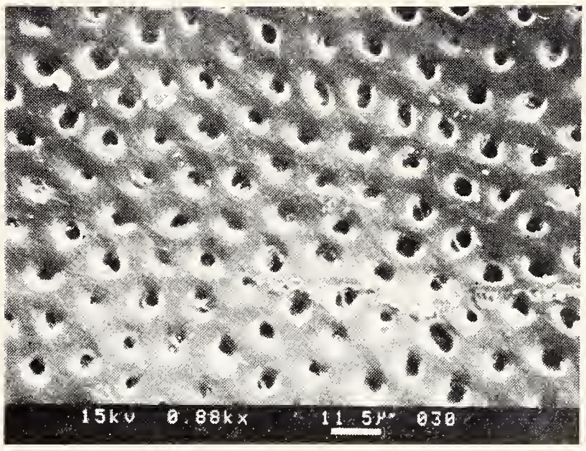
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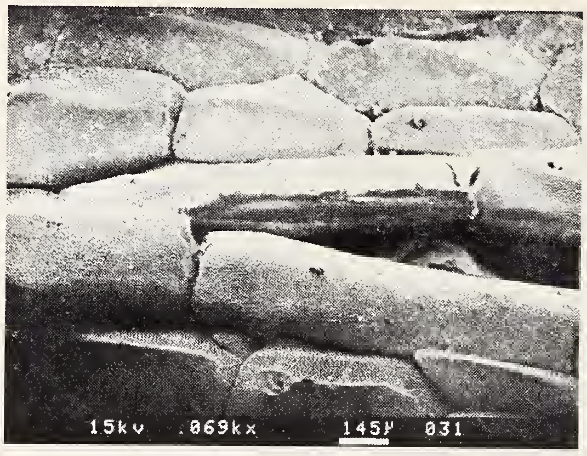
8

Head-skin structures

1. Parietal shields; 2. Detail from fig. 1, tactile papilla; 3. Eye; 4. Tactile papillae on rim of eyelid; 5. Canthal scale of supraciliary region; 6. Bristled tactile papilla of the casnthal region; 7. Surface of an eyelid scale; 8. Surface of a snout tip scute.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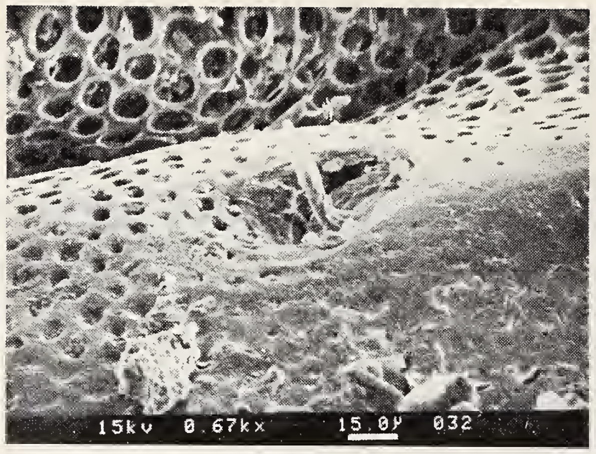
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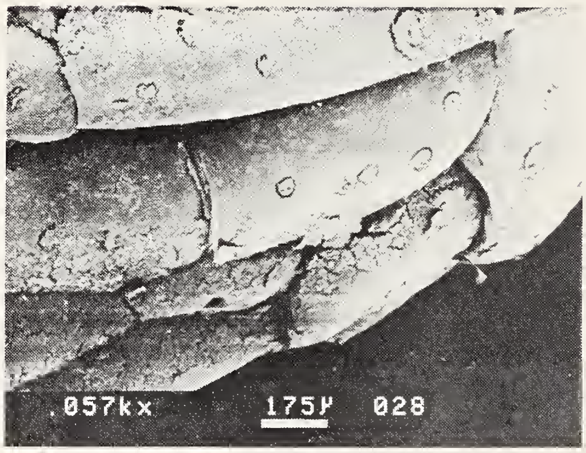
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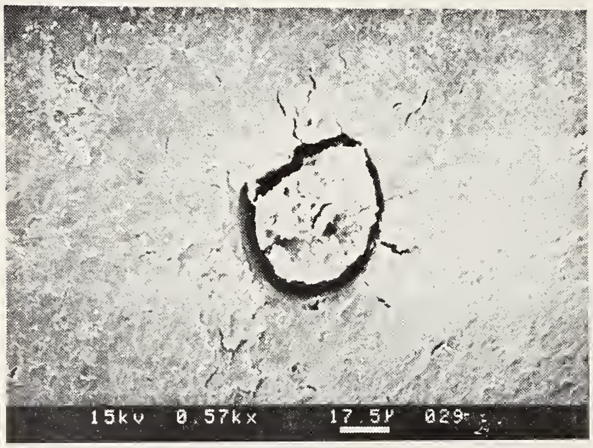
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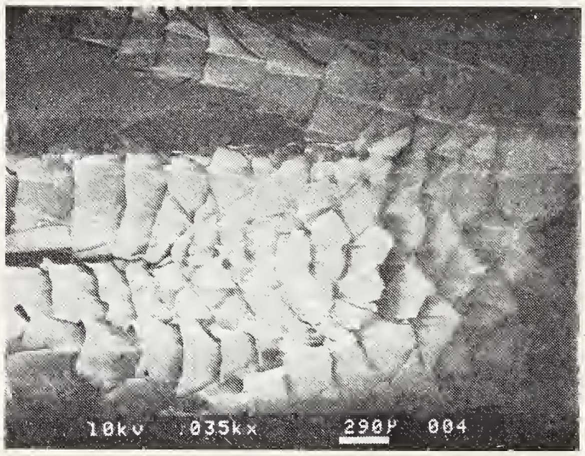
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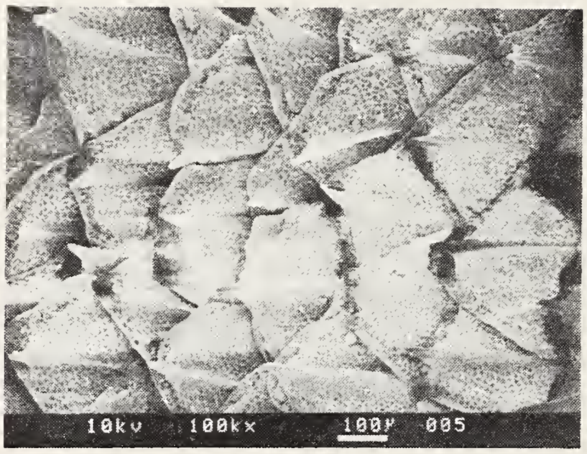
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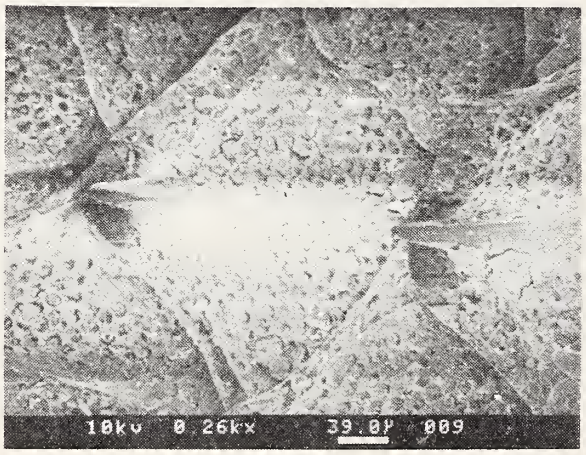
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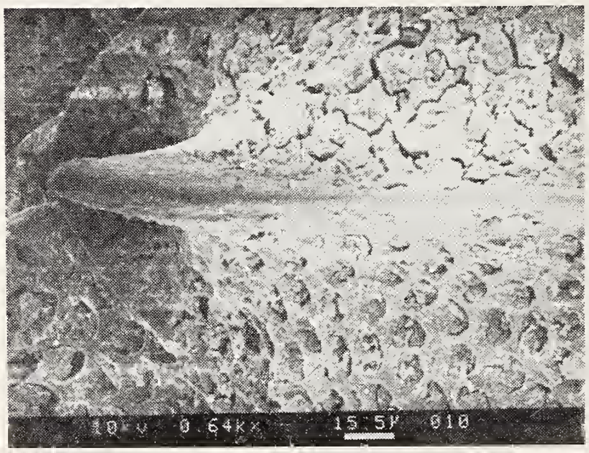
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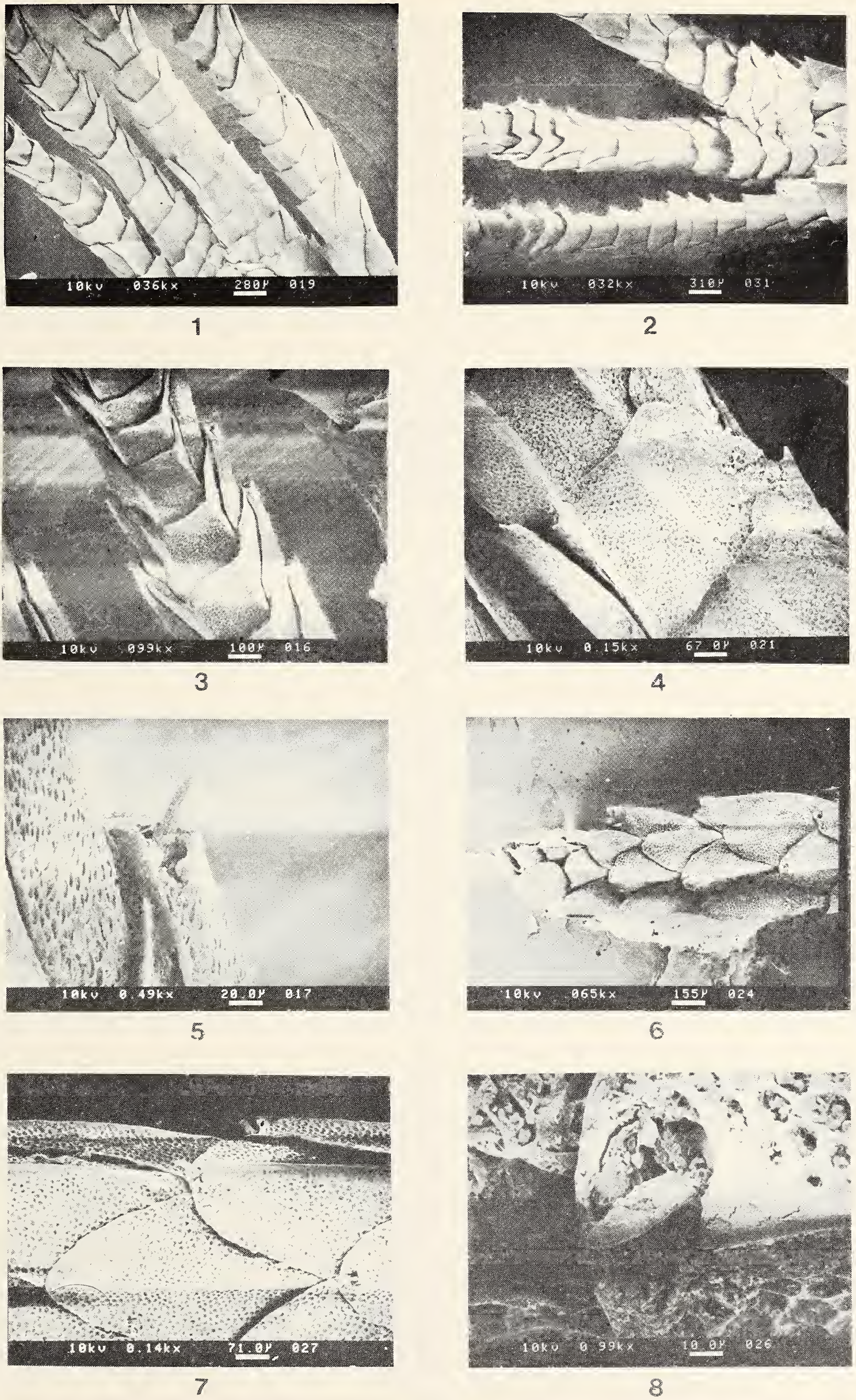
Head/hand-skin structures

1. Supra and infralabials; 2. Tactile papilla on labial; 3. Mental region; 4. Detail from 3, tactile papilla; 5. Fingers of left hand; 6. Detail from 5, palmar scales; 7. Detail from 6; 8. Detail from 7.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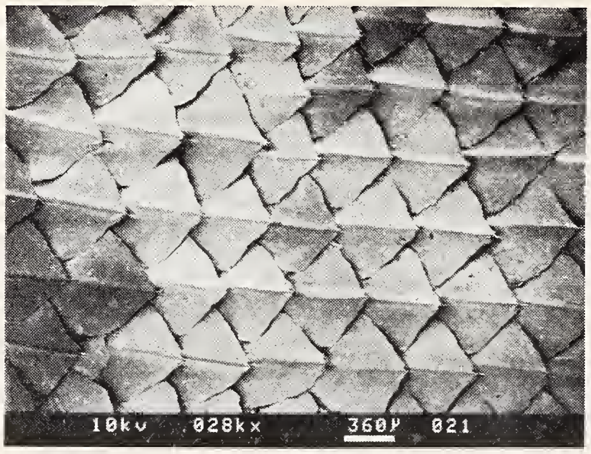
5
10kv 065kx 155µ 024
6
10kv 0.14kx 71.0µ 027
7
10kv 0.99kx 10.0µ 026
8

Hand/tail-skin structures

1. Fingers from below; 2. Fingers from below, oblique view; 3. Detail from Fig. 2; 4. Detail from Fig. 3; 5. Bristled tactile bud on side of finger; 6. Tail tip; 7. Detail from Fig. 6; 8. Detail from Fig. 7, bristled tactile organ.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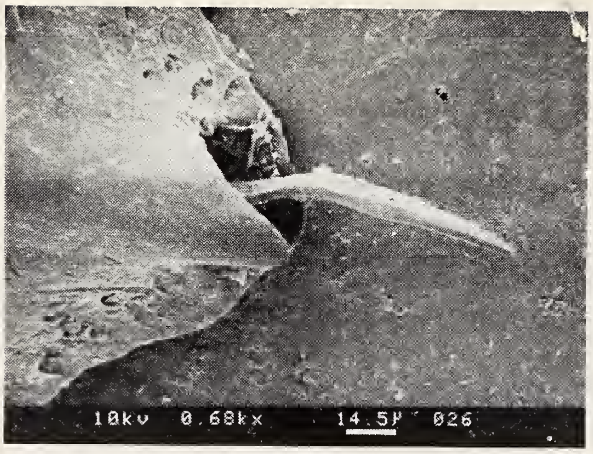
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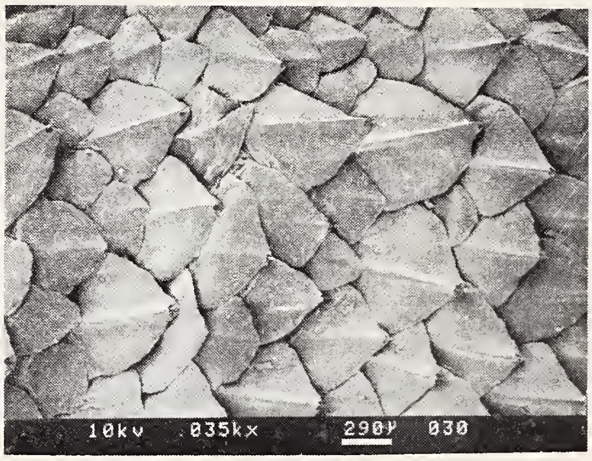
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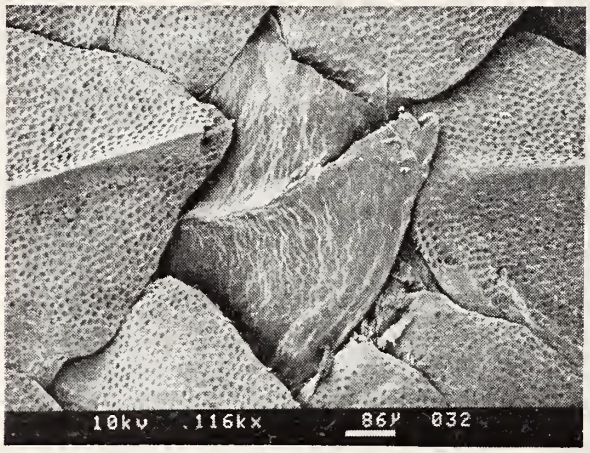
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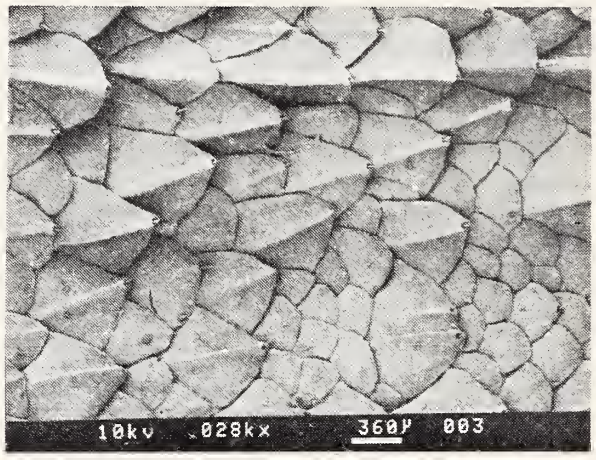
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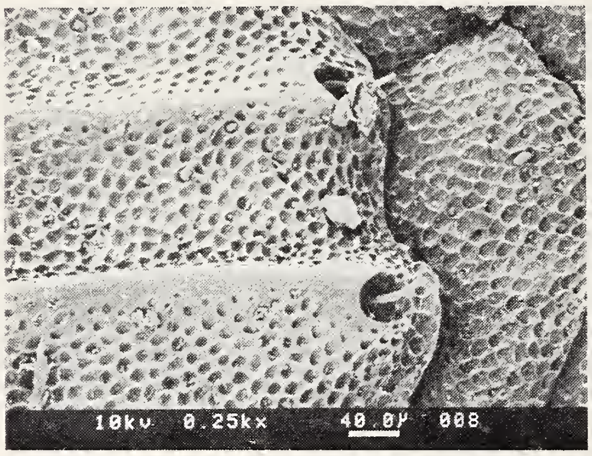
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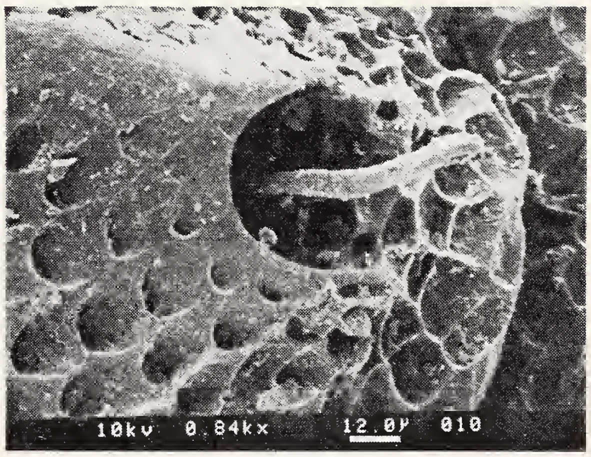
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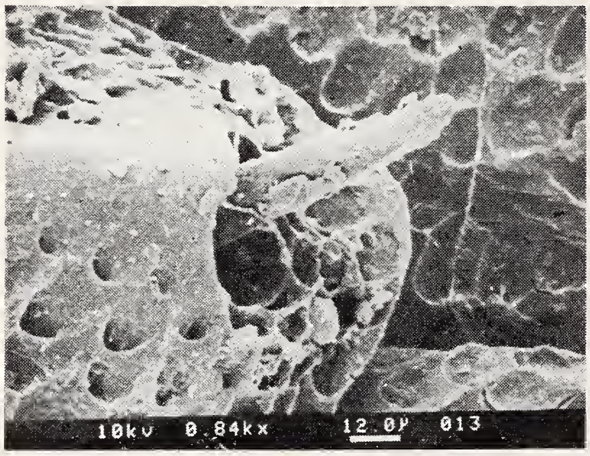
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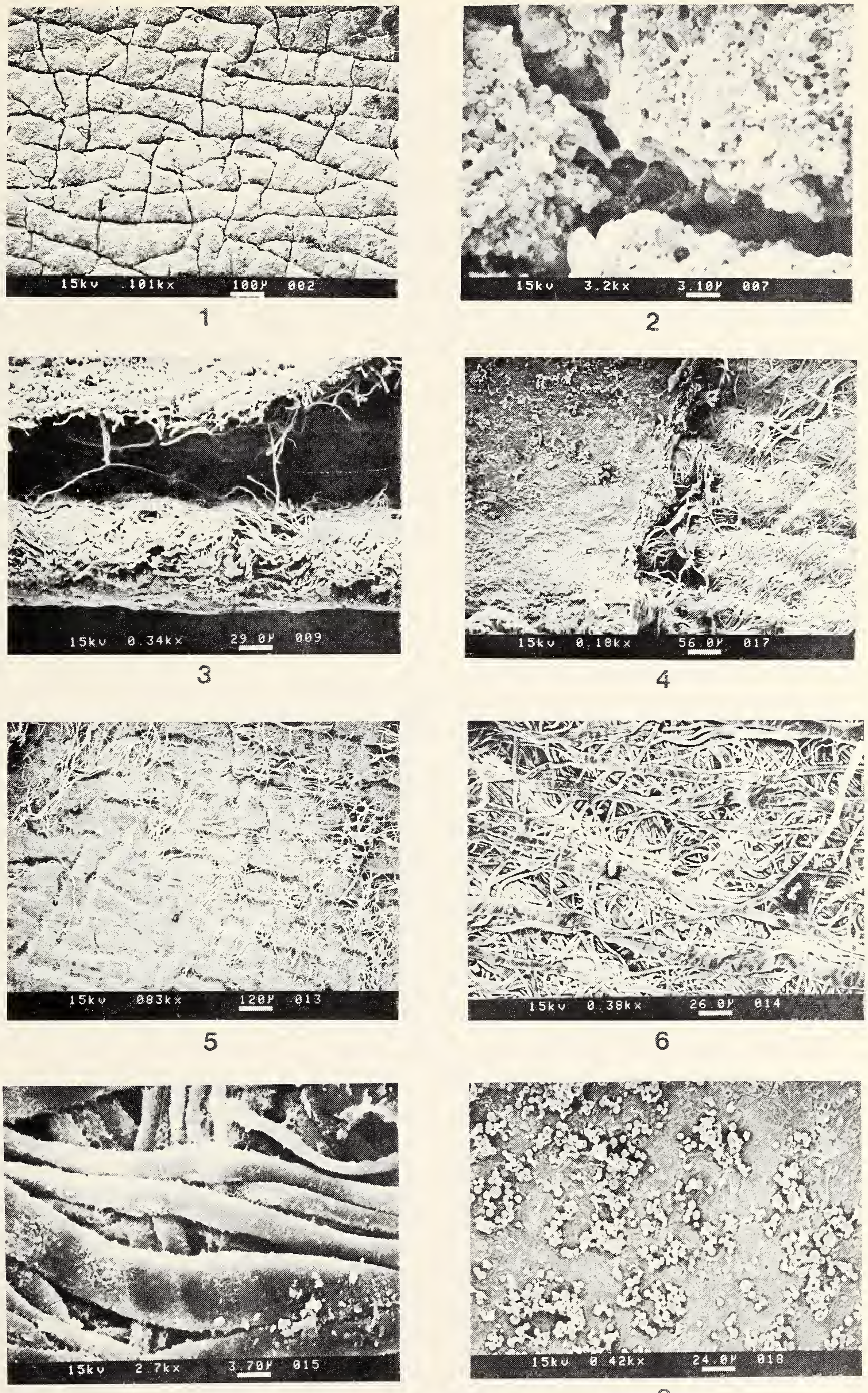
8

Body-skin structures

1. Ventral scales; 2. Detail from fig. 1, bristled tactile bud; 3. Ventrolateral scales; 4. Detail from fig. 3; 5. Dorsolateral scales; 6. Detail from fig. 5, double scale; 7. Detail from fig. 6, bristled tactile papilla; 8. Detail from fig. 5, bristled tactile papilla.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4
15kv 083kx 120µ 013
5
15kv 0.38kx 26.0µ 014
6
15kv 2.7kx 3.70µ 015
7
15kv 0.42kx 24.0µ 018
8

Eggshell Structures
1. Shell surface; 2. Detail from fig. 1; 3. Edge, total, boundary layer from below; 4. Shell from below (left half) and ceiling of membrana testacea cavity; 5. Ceiling of membrana testacea cavity; 6. Detail from fig. 5 low center; 7. Detail from fig. 6 center; 8. Boundary layer from below.

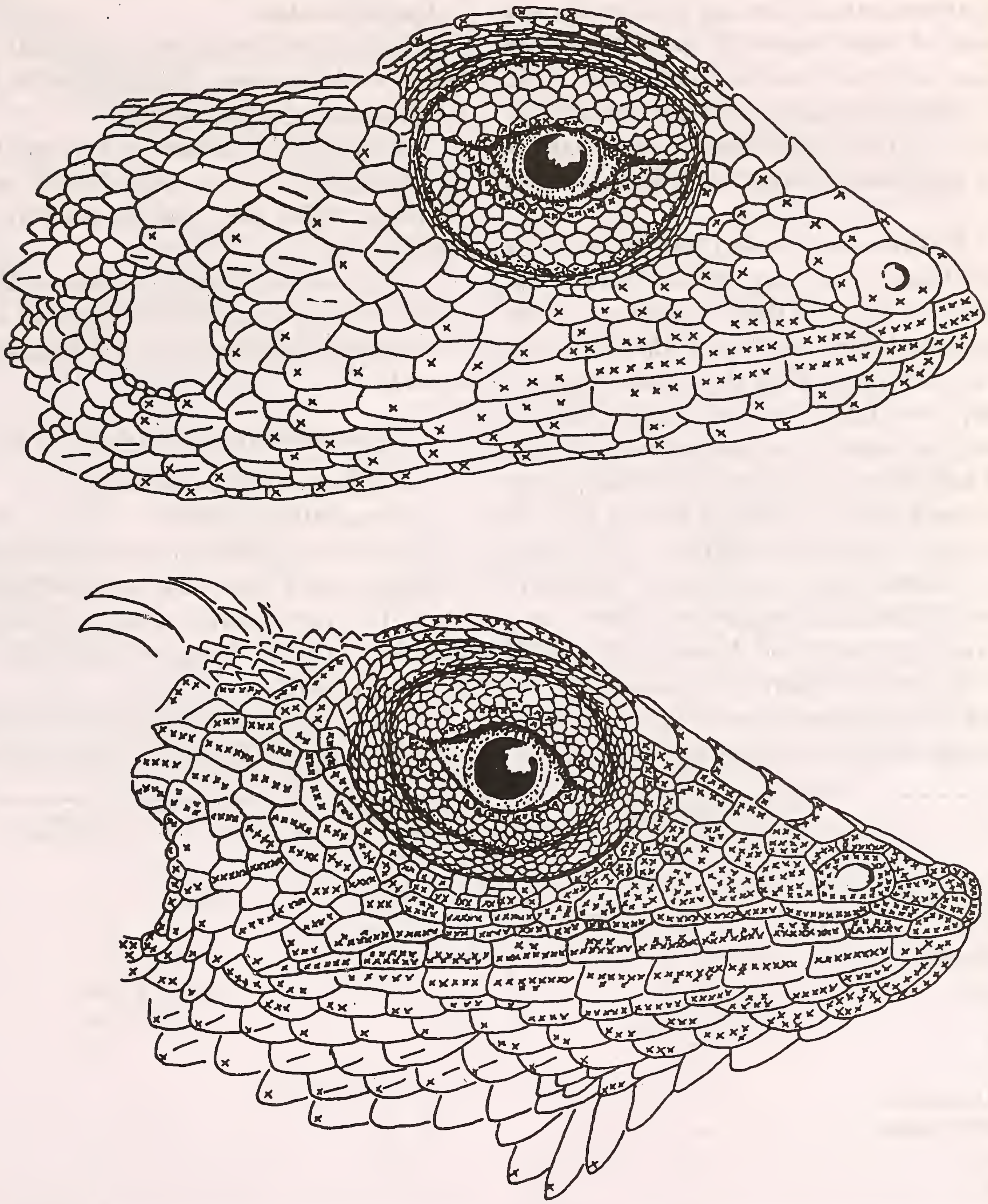

Fig. 1 Distribution of tactile papillae on the heads of *Japalura tricarinata* (above) and *Calotes jubatus* (latter redrawn after Schmidt, 1920).

lateral keel of the tricarinate species. The connection between scale size and keel formation is evident: all small scales are smooth and one oversize scale bears two keels with a tactile bud each. Keels and tactile buds are not strictly associated. A close look reveals some smooth scales with tactile buds and keeled ones without them.

1.5. **Discussion** In spite of the fact that only a limited number of body regions could be examined it is apparent that the presence of the honeycomb pattern on scales is the rule rather than the exception. Only the mental region is entirely devoid of it, on the ventral scales the alveoles are limited to the rim, the snout tip bears small and distant dimples while on the palmar scales the honeycomb pattern is very flat. All previously examined Agamids (*Aphaniotis fusca, Ceratophora stoddarti, Cophotis ceylanica, Otocryptis wiegmanni, Sitana ponticeriana*) (Schleich and Kästle 1979, 1982) show this pattern on toe scales (others were not controlled) with alveole size in the same order of magnitude of about 10 /µm. Its biological implications are unknown as well as its distribution in Lacertilian taxa.

As to tactile buds only the mental region bears bristleless ones. The distribution of the bristled buds is very uneven.

As there are some data from *Agama agama* (Harris 1963) and *Calotes jubatus* (Schmidt 1920) they can be used for comparison (fig. 1).

Speculations about the modes of distribution or the function of different types of bristles are considered premature as our knowledge is sporadic.

2. EGGSHELL STRUCTURES (fig. 2; pl. 5)

Egg quality: flexible-shelled.

Preparation: ex utero.

External and internal shell structure do not strikingly differ from other soft-shelled lizard eggs. The conventional building elements – globules and fibrils – are clearly discernible over most of the shell.

2.1. **Shell surface:** *Surface gross morphology* (pl. 5, fig. 1): Deeply incised longitudinal

	J. tricarinata	*A. agama*	*C. jubatus*
pileus	+		+
supraciliar canthus	++	++	++
eyelid rim	++		+
eyelid surface	–		+–
snout tip	–		++
mental	–		++
labials	++		++
palm	–		
ventral digit scales	–		
lateral digit scales	+		
dorsals	+–	++	+
ventrals	+	–	+
tail tip	+		+ – (tail)

++: several buds may occur on one scale/scute; +: normally one bud per scale; +– : some scales with buds, others without; –: no buds; no sign: no data.

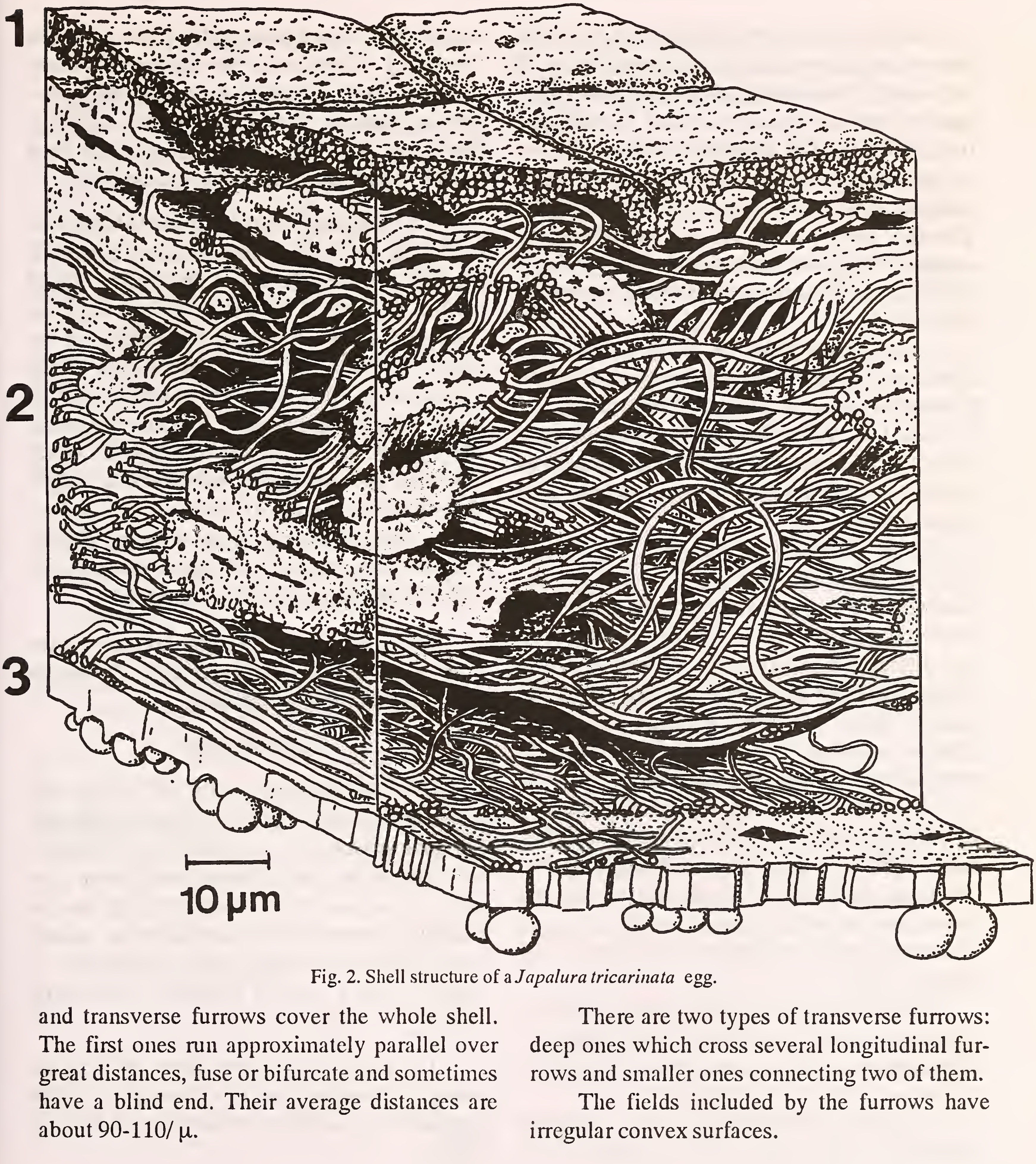

Fig. 2. Shell structure of a *Japalura tricarinata* egg.

and transverse furrows cover the whole shell. The first ones run approximately parallel over great distances, fuse or bifurcate and sometimes have a blind end. Their average distances are about 90-110/ µ.

There are two types of transverse furrows: deep ones which cross several longitudinal furrows and smaller ones connecting two of them.

The fields included by the furrows have irregular convex surfaces.

Surface fine morphology (pl. 5, fig. 2): The furrow borders are irregularly denticulated as if torn apart. The surface layer is perforated by a great number of tiny pores about 1 / μ wide and irregular slits. The globular elements are cemented together immediately or by small bridges. The open spaces left between the globules form a complex system of narrow cavities which is connected with the superficial openings and the larger open spaces of the deeper shell layers.

2.2. **Cross section:** (pl. 5, fig. 3): The large open space between the fibrillar layers was probably enlarged during the process of preparation.

2.2.1. **Covering layer:** The transition from the globular to the fibrillar layer at its base is indistinct as the fibrils are largely fused and form dense masses.

2.2.2. **Membrana testacea** (pl. 5, figs. 3-7): In this fibrillar layer a double inhomogeneity is remarkable: In the horizontal direction regions with a high degree of fusion are interspersed with large spaces of loose fibrils. An open space running parallel to the surface forms two fibrillar floors with some fibrils bridging the gap and holding the membranes together (pl. 5, fig. 3).

Seen from below (pl. 5, figs. 5-7) the roof of the gap shows a corrugated surface with furrows running at approximatively right angles. While the multitude of fibrils form a flat and dense network others, lighter in colour, spread above the surface and form a crosslink towards deeper layers.

The fibrils are very heterogenous in shape and size, rounded or flattened, some bifurcate. The diameter of the smallest ones is 1.5 / μ while the largest ribbon is 18 / μ broad.

A stronger magnification (pl. 5, fig. 7) reveals two more details: Two patches on the largest fibril are porous as if the surface has been formed by incompletely fused globules. Where covering fibrils have been torn away the former contact zones are devoid of the usual rough surface cover. This substance has apparently been unable to penetrate into the contact region.

2.3. **Boundary layer:** A dense lamella, 4-6 / μ thick, at the base of the membrana testacea is formed by fused globules and fibrils (pl. 5, figs. 4 left half, 8). In pl. 5, fig. 4 right half this layer has been torn away presenting the ceiling of the membrana testacea cavity. The border of the broken lamella (pl. 5, fig. 3) shows vertical fraction planes suggesting prismatic structural elements. The lower surface is covered with globules which are sometimes arranged in rows between ridges. Three different regions of the boundary layer show a very different density of the adhering globuli. They are very scarce in pl. 5, fig. 4, densest in pl. 5, fig. 3 and intermediate in pl. 5, fig. 8.

The rough basal part of the boundary layer offers a greatly enlargened surface for the attachment of embryonic membranes.

2.4. CONCLUSION

The two principal tasks of soft-shelled lepidosaurian eggs – protection and permeability for some substances – can evidently be attained by different structural plans even under very similar conditions in the nests. It is, e.g. not yet possible to correlate the occurrence of globuli versus fibrils in the shell surface layer even in closely related species (Schleich and Kästle 1988).

The physical aspects connected with the energy and substance flow through reptilian eggshells are discussed in Packard and Packard (1988).

ACKNOWLEDGEMENTS

During the first excursion in June 1989 the habitat of *Japalura tricarinata* was studied and 14 specimens were caught. The field trip was organized by the Tribhuvan University (Dept. Geology) with participants from the Department of Geology and the Natural History Museum. A second excursion was made possible by the Goethe Institute, Kathmandu, in July 1991.

We deeply acknowledge the efforts of the heads of following institutions who facilitated our stay and research/lecture period in Nepal: Dr. Sharma (Dept. Geol. Tribhuvan Univ.), R.L. Shrestha and Dr. M. Giri (Nat . Hist. Mus.), Mr. B. Upreti and Dr. T. Maskey (National Parks and Wildlife Service). Without the friendship and personal help from Mr. Shashi Bandari (Shashi's Holiday Tourist Travels, Kathmandu) we would not have been able to solve customs and other problems we faced while importing our equipment.

We also express our gratitude to Dr. U. Gruber and Mr. D. Fuchs, Zool. State Collection Munich, for help with literature, collegial cooperation and assistance during field trips in 1989. Mr. G. Wester (Landshut) gave most valuable help during the 1991 field trips in the search and observation of specimens at Phulchoki and Mt. Daman. One of the authors (H.H.S.) wishes to particularly express acknowledgements to DAAD and Goethe Institut who financed both trips to Nepal for lecture programs.

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NEW DESCRIPTIONS

FIRST RECORD OF GENUS *DIPRION* SCHRANK (HYMENOPTERA : SYMPHYTA : DIPRIONIDAE) FROM INDIA, WITH DESCRIPTION OF A NEW SPECIES[1]

MALKIAT S. SAINI AND AMARINDER S. THIND[2]

(With five text-figuers)

A new species of genus *Diprion, D. Kashmirensis*, has been described and illustrated. This represents the first record of this genus from India. Previously only four species of this genus were known from the Oriental region.

INTRODUCTION

The genus *Diprion* was erected by Schrank (1802), but its type species *Tenthredo pini* Linn. was subsequently designated by Rohwer (1911). Later on three genera, i.e. *Lophyrus, Anachoreta* and *Cristger* were synonymised with it, because all were based on the same type-species. Smith (1975) listed six species of this genus from the world, none from the Oriental region. Presently four species of this genus are known from the Oriental region.

This genus is characterised as follows : Cenchri small, close together, distance between them less than the breadth of a cenchrus; metascutellum small, shorter than breadth of a cenchrus (Fig. 3); forewing with first cubital cell not more than half as long as broad; anal cell of forewing narrowed at a point just under one-third from the base and with a short cross-vein just behind the middle (Fig. 1); anal cell of hindwing has a long petiole much longer than the maximum breadth of the cell (Fig. 2). This genus is a first record from India, represented by a new species *Diprion kashmirensis*

Abbreviations: EL = Eye length; IATS = Inner apical tibial spur; ICD = Intercenchri distance; IDMO = Interocular distance at the level of median ocellus; ITD = Intertegular distance; LID = Lower interocular distance; MB = Metabasitarsus; OATS = Outer apical tibial spur; OCL = Ocello-occipital line; OOL = Oculo-ocellar line; POL= Postocellar line.

DIPRION KASHMIRENSIS sp. nov.

(Figs. 4, 5)

MALE: Colour: Body black, labrum, maxillary and labial palpi, apices of all femora, all tibiae and tarsi except claws yellow. Antenna, tegula, deflexed sides of terga 2-8, all coxae, all trochanters, all femora except their apices, and all claws brown. Wings hyaline; costa, stigma and venation yellow to light brown.

Length 7 mm. Antenna 1.1 x head width, 22-segmented, flagellum with 17 bipectinate and 3 terminal unipectinate segments; clypeus roundly incised up to one-fourth of its median length, with an irregular base; labrum rounded at the apex, broader than long in ratio 2:1; malar space 1.5 x diameter of median ocellus; supraclypeal furrow merely indicated; supraclypeal area roundly but moderately raised; lower margin of eyes almost at the level of antennal sockets; LID : IDMO : EL = 4:4:1.8; eyes parallel; head without postgenal carina; frontal area above the level of eyes, supra-antennal tubercles slightly raised and confluent behind with similar frontal ridges; median fovea in the form of groove between antennal sockets, posteriorly ending in a pit; lateral ocelli below the level of supraorbital line; circum-, inter- and postocellar furrows present; lateral furrows diverging posteriorly; postocellar area convex, broader than long in the ratio of 2:1; OOL : POL : OCL = 1.1 : 1 : 0.8; head narrowing behind eyes : mesoscutellum flat; ICD :ITD = 1 :

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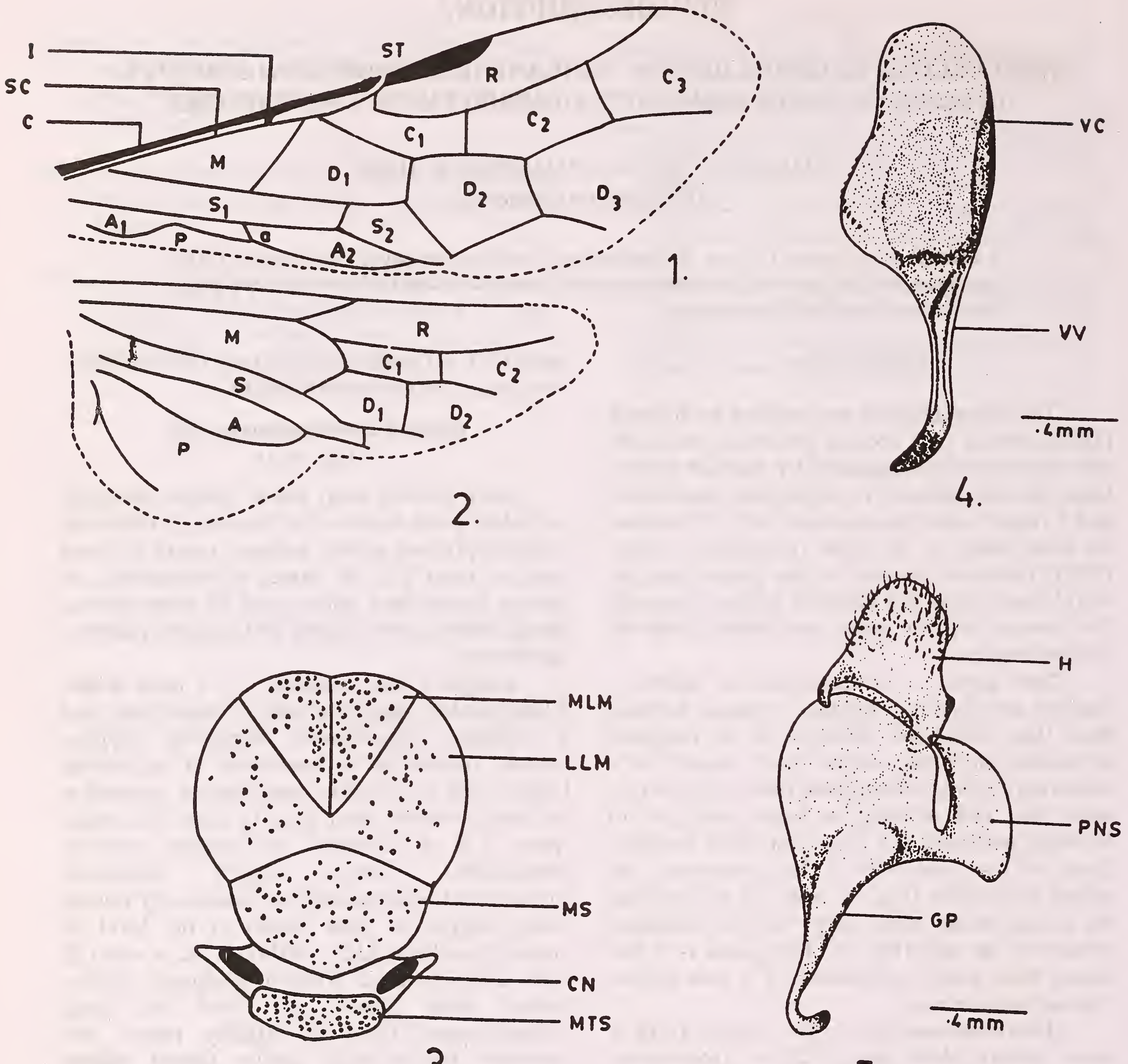
Patiala 147 002.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VV
·4mm
4.
MLM
LLM
MS
CN
MTS
3.
H
PNS
GP
·4mm
5.

Figs. 1-5. *Diprion kashmirensis* sp. nov.
1. Forewing, 2. Hindwing, 3. Mesonotum and metanotum, 4. Penis valve, 5. Gonoforceps.
A = Anal cell, a = Anal cross-vein, C = Costa, C1 .... C4 = cubital cells, CN = Cenchri, D = Discoidal cell, GP = Gonostipes, H = Harpe, I = Intercostal cross-vein, LLM = Lateral lobe of mesonotum, M = Median cell, MLM = Median lobe of mesonotum, MS = Mesocutellum, MTS = Metascutellum, P = Posterior cell, PNS = Parapennis, R = Radial cell, S = Submedian cell, S = Subcosta, ST = stigma, VC = Valviceps, VV = Valvura. (For other abbareviations, see text).

4.5; distance between cenchri 1.4 x width of cenchrus; mesepisternum obtusely raised without carina or acute apex; metabasitarsus and three following segments combined are in ratio 1 : 1.5; tarsal claws simple without inner tooth; IATS : MB : OATS = 1 : 2 : 1.

Male genitalia: Penis valve (Fig. 4). Gonoforceps (Fig. 5).

Sculpture: Head and thorax with large deep, irregular confluent punctures; abdomen excepting anterior margin and middle of first abdominal tergum, deflexed sides of all terga and all sternites are distinctly punctured. The remaining terga are cross-striated.

FEMALE : Not found.

Holotype: Male, Jammu and Kashmir: Pahalgam, 2700 m. 5 June 1984. Regd. No., D1/RIT/ZPD. Holotype presently in anthor's collection. After this paper is published it will be submitted to the IARI, New Delhi.

Population variation: Single specimen examined.

Distribution: INDIA: Jammu & Kashmir.

Diagnosis: On the basis of black colouration of body, this new species is close to the male of *D. hytacharernae* Smith, but varies as follows : in *D. Kashmirensis*, head and thorax have large, deep irregular confluent punctures; abdomen excepting the anterior margin and middle of first abdominal tergum, deflexed sides of all terga and all sternites are distinctly punctured. In *D. hytacharernae* punctures of head and thorax are dense with very short or without inter-spaces; dorsum of abdomen not punctured except extreme lateral area of terga and sterna which are punctured.

Etymology: The species name is based on the Indian state in which the collection locality falls.

ACKNOWLEDGEMENTS

We are thankful to Dr. D.R. Smith (USNM Washington) for endowing the type of *D. hytacharernae* a species that closely resembles *D. kashmirensis* sp. nov. The financial assistance rendered by CSIR, New Delhi is also gratefully acknowledged.

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A NEW GENUS OF ANTHURIDAE (CRUSTACEA: ISOPODA: ANTHURIDEA) FROM VISAKHAPATNAM COAST[1]

C. JALAJA KUMARI, K. HANUMANTHA RAO AND K. SHYAMASUNDARI[2]

(*With seventeen text-figures*)

A new anthurid genus, namely *Heteranthroides* gen. nov. and a new species, *H. rishikondensis* sp. nov. of the family Anthuridae is described from Visakhapatnam coast (Bay of Bengal), collected from the sponge *Callyspongia fibrosa*. Similarities and dissimilarities and related genera and species are discussed.

In the present paper, a new genus *Heteranthroides* of the family Anthuridae and a new species *Heteranthroides rishikondensis* are described.

Heteranthroides gen. nov.

Large eyes present in male. Antennular flagellum of eight articles and peduncle of two

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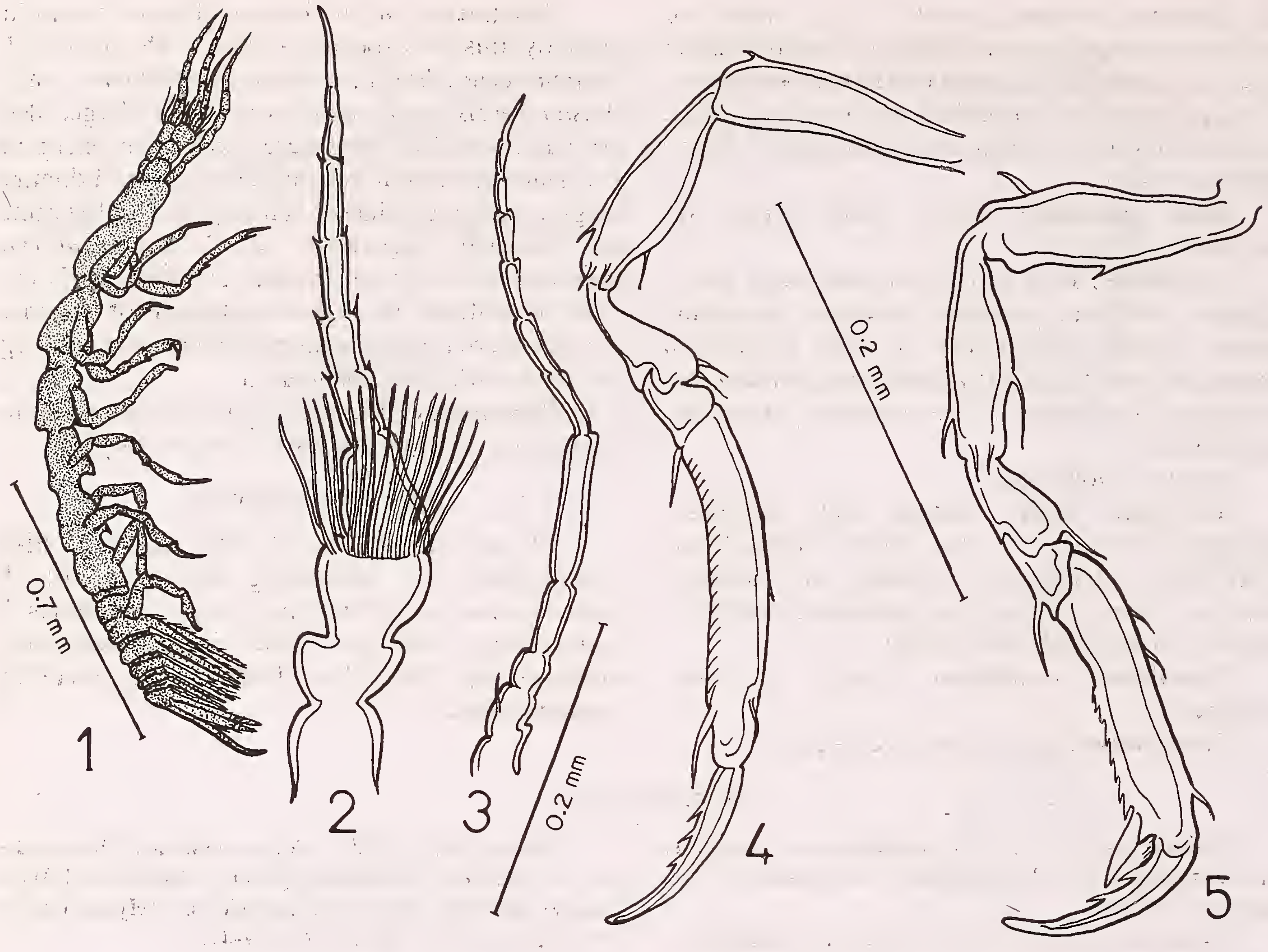


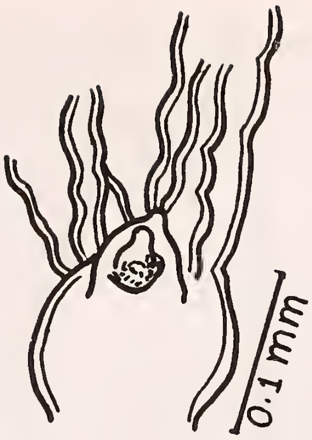
Fig. 1. *Heteranthroides rishikondensis* sp. nov. ; Fig. 2. Antennule; Fig. 3. Antenna; Fig. 4. First pereopod; Fig. 5. Second pereopod.

segments, antennal flagellum of six articles, rostrum present. Maxilliped small and seven-segmented. Pereonites 1-6 with mid-dorsal pit. All pereopods non-chelate, not underriding propodus. Pleonites 1-4 free and distinct, pleonite 5 concealed. Dorsal apex of exopod provided with a strong, blunt brush spine.

The new genus is allied to *Allanthura* Kensley, 1980 in the presence of eyes, in the well developed incisor, lacinia and molar of mandible and operculiform first pleopod, but differs in the segmentation of antennule and antenna, the number of segments of maxilliped, in the pereopodal structure and the fused nature of pleonites 1-5 and the pleonite 6 not being united. It shows a similarity to the genus *Diaphoranthura* in the presence of eyes, in the segmentation of flagellum of antennae, in the well developed incisor, lacinia and molar; in the operculiform first pleopod; in having 1-6 free pleonites and differs in antennule, segmentation of maxilliped, in the subchelate nature of pereopods 1-3 and a telson which bears a single median statocyst.

It resembles *Exallanthura* Kensley, 1980 in the presence of eyes, in well developed lacinia, incisor and molar and differs in the segmentation of maxillipeds and the subchelate nature of first pereopod, and the present form has a seventh pereopod.

The present genus resembles the genus *Heteranthura* in the seven-segmented maxilliped and middorsal pit in each 1-6 pereonites; it differs in



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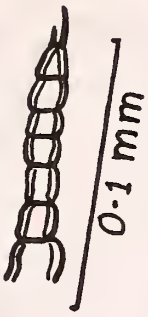

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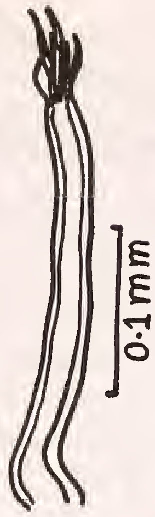

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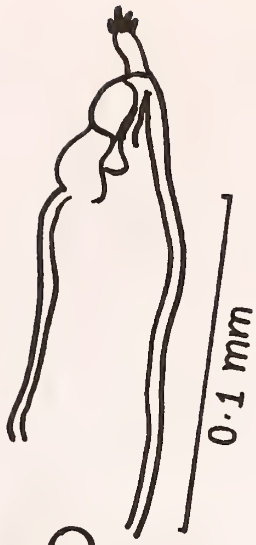

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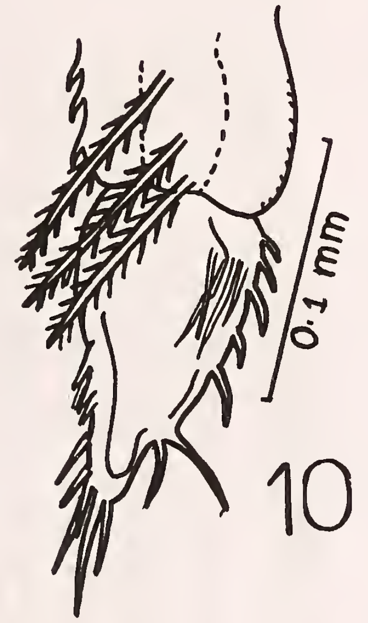

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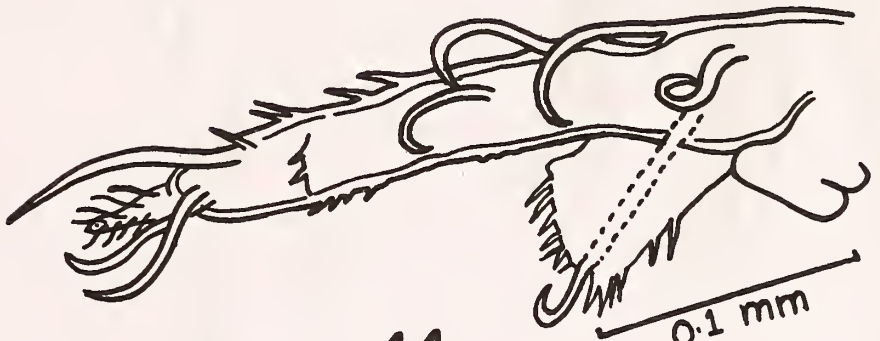

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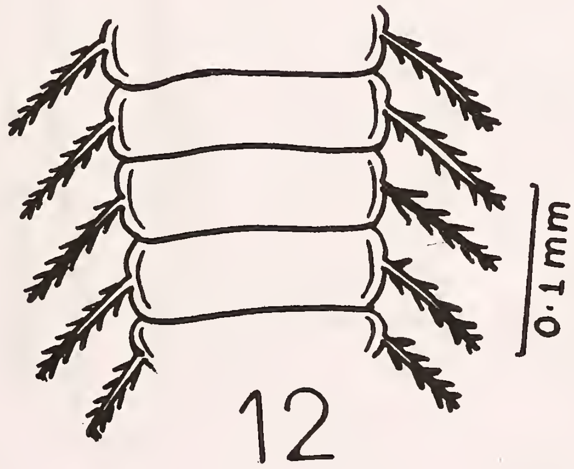

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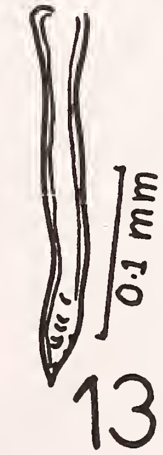

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Fig. 6. Ventral view of cephalon; Fig. 7. Maxilliped; Fig. 8. Maxillule; Fig. 9. Mandible; Fig. 10. Uropodal endopod; Fig. 11. Uropodal exopod; Fig. 12. Pleon; Fig. 13. Masculinum appendix of second pleopod.

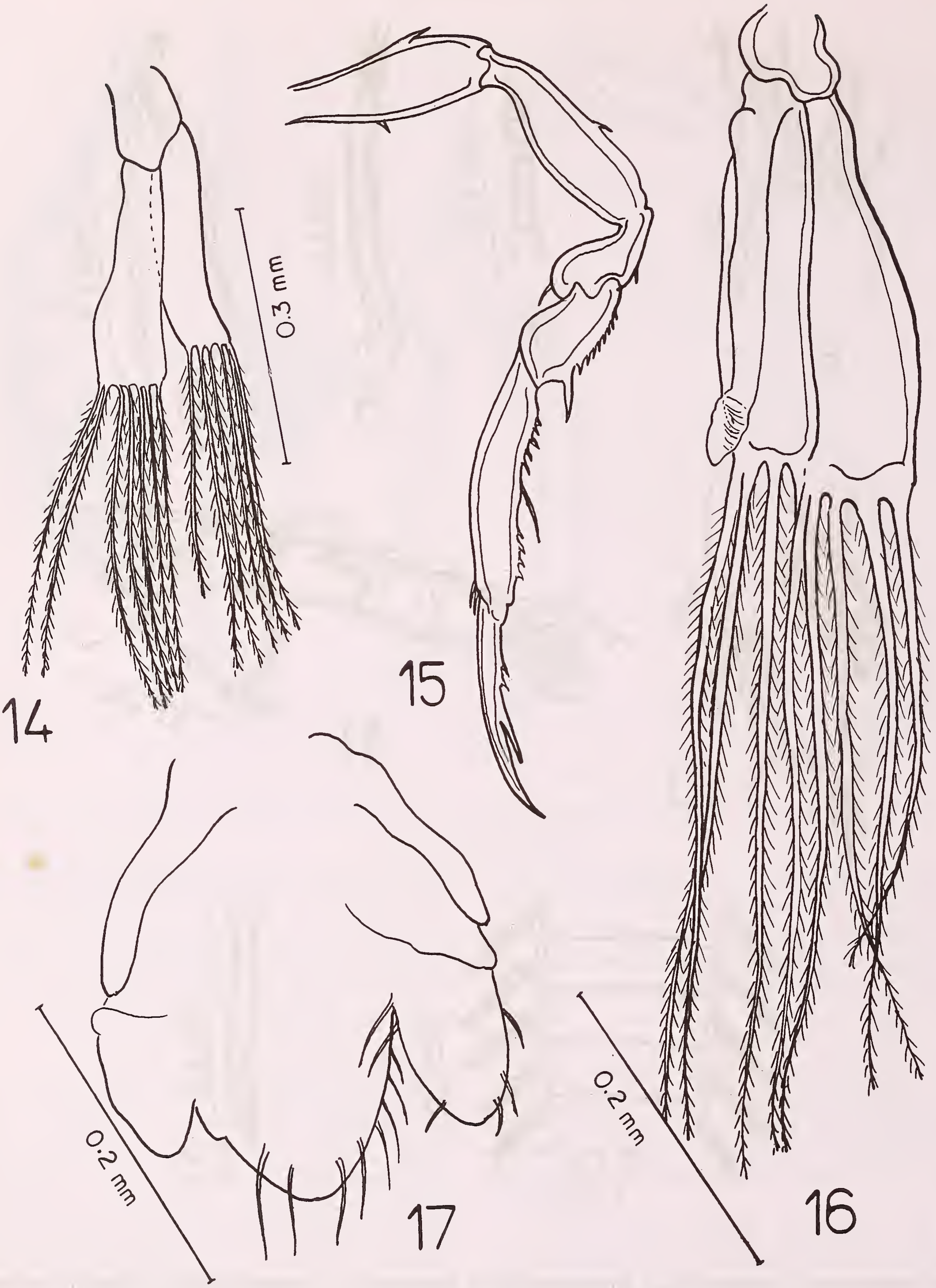
0.3 mm
14
15
0.2 mm
17
0.2 mm
16

Fig. 14. First pleopod; Fig. 15. Fourth pereopod; Fig. 16. Second pleopod; Fig. 17. Telson.

the segmentation of antennule and antenna and the reduced mandible.

Thus taking the present specimens into account, the characters sufficient to create a new genus *Heteranthroides*

Heteranthroides rishikondensis
sp. nov.

MALE: Body slender and elongated, cephalon slightly more than half the length of first pereonite; pereonites two and three equal in length and first pereonite slightly shorter than them; fourth shorter than first; fifth and sixth about equal in length and seventh shortest. Cephalon wider than long; very large composite eye present. The anterior margin of cephalon produced anteriorly between the two antennae which may be due to the closely packed antennules. The last two segments of pleon not very distinct, each pleonite gives off a plumose seta laterally.

The peduncle of antennule two-segmented, these are very thick, the basal segment is slightly longer than the second. The flagellum comprises eight segments. The first flagellar segment bears a cluster of very long aesthetascs which are arranged in three to four tiers. The terminal segment bears two large spines and the fourth, fifth, sixth and seventh segments bear an aesthetasc each. The antenna has a flagellum of six segments, the terminal three segments of which are provided with setae.

Rostrum of cephalon low, from the ventral side, the oral aperture has a rounded base and extends along the sides of rostrum which is rather conical. At its base the apices of setae and hairs of mouth parts can be seen. Maxillule slender and elongated and the terminal region provided with setae. Maxilliped very small, slender and 7-segments; the apical segment bears two setae. The segmentation of mandibular palp not distinct but incisor, lacinia and molar well developed.

The unguis of first pereopod sharper and smallest of all and about three times the length of dactyle, the dactylus is longer and slender, the propodus is not straight but slightly bent and armed with 21-22 spinules and one strong ventro-distal spine, carpus reduced and bears 6 simple setae and one long seta. The unguis of second pereopod is one and two thirds the length of dactyli. The propodus is broader and shorter and bears a long simple seta in the inner margin, on either side of which are arranged 10 smaller simple setae and one stout spine at its apex; the carpus is broader and bears only one seta on the inner margin and about 3 longer simple setae on the outer margin. The unguis of seventh pereopod is one and one third the length of dactylus. The propodus is slender and elongated, the inner margin bears 6 simple setae and there is a spine at its apex, the arch beyond it is fringed with small setae.

The fifth pleonite not distinct, all pleonites provided with a plumose seta each on either side. The endopod of first pleopod provided with five long plumose setae and the exopod with 7 plumose setae. The appendix masculinum of second pleopod is slightly longer than the endopod, it has a regular outlined lip up to about four fifths of the length where it broadens and tapers to an acute tip; in this region the margin is irregular or almost serrated and the first pair of pleopods are operculiform.

The outline of telson is roughly linguiform. The tip of posterior margin has small setae, on either side of which are arranged about 8 setae; of these the posterior ones are small and the four that occur towards the apex are long. The ventral region of exopod bears three very long and strong plumose setae arranged one below the other, and the dorsal region of exopod is hairy and covered with about 7 very long simple setae and its apex terminates in a thick and strong blunt brush-spine; its ventral region is transparent and lamellar in structure at the apex of which arises a long seta and the margin of this structure bears simple seta. The inner margin of uropodal rami bears about 6 setae and the outer margin is fringed with hairs.

Localities: The specimens were collected from the rocky intertidal region of Rishikonda, Visakhapatnam.

Material studied: Three male specimens were collected from the sponge *Callyspongia fibrosa* along the rocky intertidal region of Rishikonda, Visakhapatnam. Holotype 1 male and paratypes 2 males are kept in the Department of Zoology, Andhra University, Visakhapatnam.

Habitat: The specimens were found in association with the sponge *Callyspongia fibrosa* as commensals.

DISCUSSION

The present form resembles *Panathura macronesia* Kensley, 1980 in bearing very thick and stout peduncular segments but differs in the number of segmentation and in all other characters. It resembles *Malacanthura mombase* Kensley, 1980 in having large eyes and well developed incisor, lacinia and molar of mandible, but differs in all other features. It resembles *Exallanthura sexpes* Kensley, 1980 in having the incisor, lacina and molar of mandible but differs in all other particulars. The present form resembles *Diaphoranthura hapla* Kensley, 1980 in the segmentation of antennal flagellar segmentation and in the presence of incisor, lacinia, molar, and the uropodal exopod folds dorsally over telson, but differs in the other characters. It resembles *Diaphoranthura cracens* Kensley, 1980 in having well developed eyes, and a relatively large rostrum and in both, the antennal flagella is 6-segmented; they differ in all other characters. The present form resembles *Heteranthura anomala* Kensley, 1980 in the indurate integument, with a low rostrum, a 7–segmented maxilliped, presence of mid-dorsal pit in pereonite 1-6, free pleonite, 1-5 subequal, and each pleonite with prominent plumose seta laterally, but differs in the segmentation of antennule and antenna and the mouthparts and in all other characters.

Since the present form differs from all the above species in the aforestated characters, it is described as a new species.

ACKNOWLEDGEMENTS

One of us (C.J.K.) is grateful to the Council of Scientific and Industrial Research for financial assistance. We are thankful to the authorities of Andhra University for providing facilities.

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AENHENRYA: A NEW GENUS OF ORCHIDACEAE FROM SOUTHERN INDIA[1]

R. GOPALAN[2]

(With nine text-figures)

This new genus is based on a recent gathering by me from the Agastyamalai range in the Southern W. Ghats of India, a region that continues to yield a steady stream of novelties in orchids and other families.

Aenhenrya gen. nov.

Herba terrestris; rhizoma repens, crassum, moniliforme, succulentum (hyalinum); radices pilosae, pusillae, fasciculatae; caules decumbentibus, succulentis. Folia orbiculo-ovata, carnosa. Inflo-rescentia 1-2-florate; scapus albohirsutus; flores albi. Sepala alba, extus longo-hirsuta; sepala dorsalis petalis labio et columna includentia. Petalis falcato-oblonga. Labium ad basim columnae affixum, 3-labatum; labia lateralia duplicato-plicata, margo fimbriatus; midlobus 3-lobulatus, lobulus lateralis oblongo-ovatus, midlobulus triangulare rostratus; appendix ensata ad basim labii adnatus; ligula 2 ad basim labii adnatus. Columna longa, crassa, angularis, dorse sulcuta, furcata ad apicem 2-densibus semi-lunaribus; appendices 2 in sulcum dorsalem inclusae; appendix supera curta, linearis et

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[1] Accepted January 1993.

[2] Botanical Survey of India, Southern Circle,
Coimbatore 641 003.

Table 1

Characters	*Aenhenrya* gen. nov.	*Anectochilus* Blume
Leaves	Fleshy.	Membranous.
Inflorescence	1-2-flowered; peduncle white hairy.	2-12-flowered; peduncle glandular pubescent.
Lip	Not spurred or saccate.	Spurred or saccate.
	Appendage sword-like, partially adnate to the base of lip; ligules two, auricular, one on either side at base of lip.	Appendage and ligules absent.
	Mid-lobe of lip 3-lobules.	Mid-lobe of lip 2-lobules.
Column	Long, thick, angular, dorsally grooved, narrowed towards apex, forked or biclawed; appendages 2, embedded along the groove.	Short, 2-4-winged; appendages absent.
Pollinia	Absent.	2, pyriform or clavate.

acutus, infra taeniaformis apica rotundo. Pollinia absentia.

Herbs, terrestrial; rhizome creeping, thick, moniliform, succulent (transparent); roots hairy, short in bunches; stem decumbent. Leaves orbicular-ovate, fleshy. Inflorescence 1-2-flowered; scape white-hairy; flowers white. Sepals white, long hairy outside; dorsal sepal enclosing petals, lip and column. Petals falcate-oblong. Lip attached to base of the column, 3- lobed; side lobes double-folded, margin fringed; midlobe 3-lobuled, side lobule oblong-ovate, midlobule triangular-beaked; a sword-like appendage partially adnate to the base of lip; ligules 2, auricular, at the base of lip. Column long, thick angular, dorsally grooved, forked with 2-semilunar prongs at apex; appendages 2, embedded in the dorsal groove, upper short, linear and acute, lower ribbon-shaped with rounded apex. Pollinia-absent.

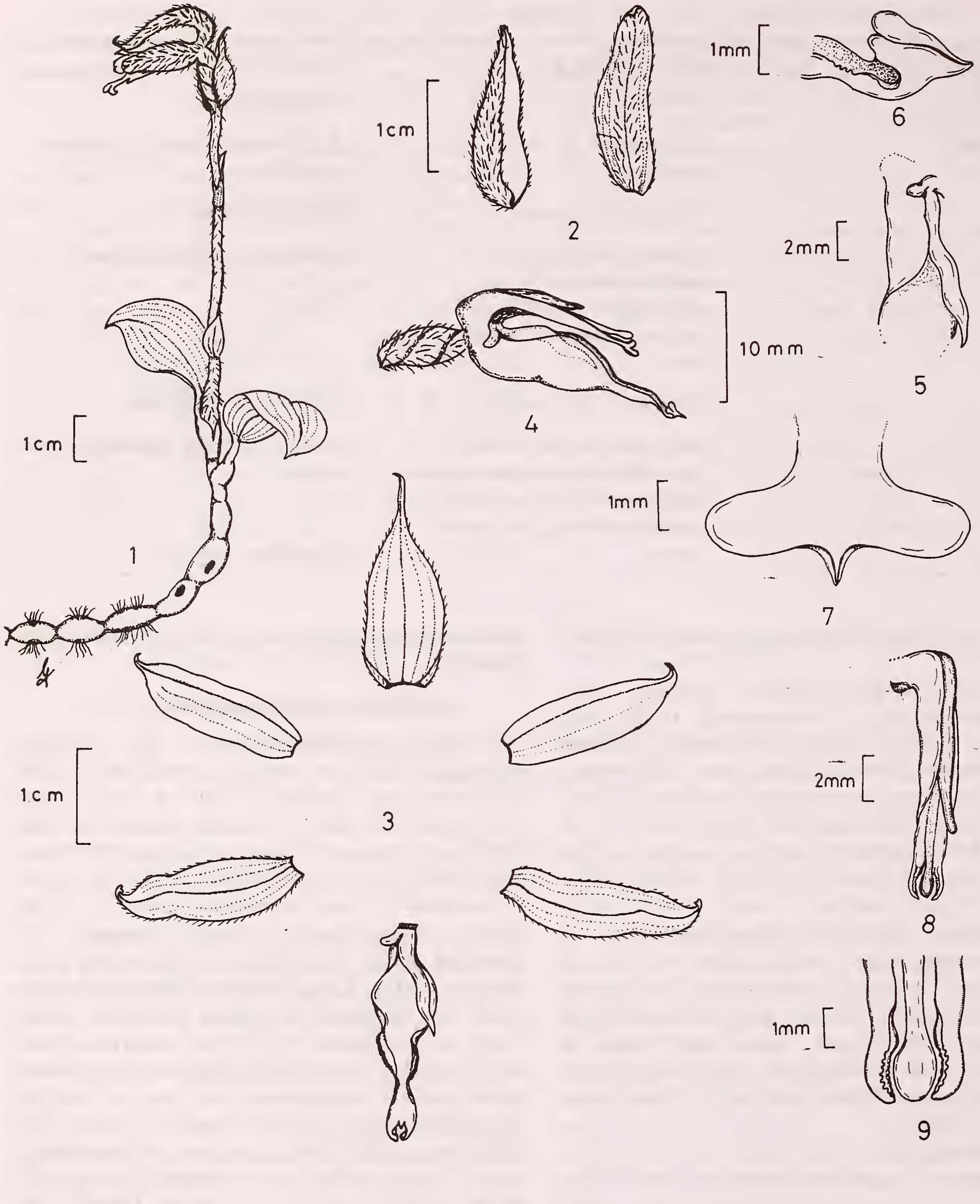
Monotypic.

Typus: *A. agastyamalayana* sp. nov. (Figs. 1-9)

The genus is unique in Orchidaceae showing characters which are not found in any other genus. From the general appearance of the plant it looks similar to *Anectochilus*, but can be differentiated as Table 1.

Aenhenrya agastyamalayana sp. nov.

Herbs, terrestrial, *c.* 20 cm tall, succulent, translucent. Rhizome creeping, moniliform, rooted at internodes. Leaves 15-30 x 2-22 mm, orbicular-ovate, fleshy, glabrous, rounded at base, entire, acute at apex, 5-9-nerved; petioles 10-15 mm long, fleshy, pink, amplexicaule, *c.* 10 mm, adnate or sheathed to stem, translucent. Scape *c.* 6 cm long, white-pubescent, leafy bracteate, 1-2 flowered. Leafy sterile bract at base of the scape larger, *c.* 10 x 5 mm, broadly elliptic-lanceolate, acute to acuminate at apex, 5-nerved (rarely 3-nerved), reticulate; middle bract empty, *c.* 11 x 2 mm, linear-lanceolate, white hairy outside, glabrous inside, acute to acuminate at apex, hairy at margins; floral bracts up to 10 x 8 mm, linear to ovate-lanceolate, acute to long-acuminate and recurved at apex, densely white-hairy outside. Flowers 1-2, white, sessile, densely white-hairy. Dorsal sepal 15-23 x 8-10 mm, ovate-lanceolate, concave, entire, long-acuminate, with *c.* 6 mm long acumen, mucronate and recurved at apex, hairy outside,


1cm
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6
2mm
5
10 mm
4
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7
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3
2mm
8
1mm
9

Figs. 1-9. *Aenhenrya agastyamalayana* sp. nov.
1. Habit; 2. Dorsal and lateral sepals; 3. Sepals, petals and lip spread out from front; 4. Column and lip (side view); 5. Base of lip showing ligule and sword-like appendage; 6. Midlobe of lip (side view); 7. Midlobe spread out; 8. Column; 9. Apex of column.

glabrous inside, 5-nerved; lateral sepals 20-22 x 5-6 mm, ensiform to obliquely lanceolate, entire or slightly undulate at margin, with thick acumen, incurved and mucronate at apex, hairy outside (more on midrib), glabrous inside, 5-nerved. Petals 17-20 x 5-6 mm long, falcate-oblong, entire, recurved and mucronate at apex, minutely tubercled; midrib thick towards upper margin ending in a mucro, with 2 thin additional nerves below the midrib. Lip 17-20 x 10-12 mm, attached to base of the column, 3-lobed, ligulate; ligules 2, auricular at base of lip; a sword-like 10 mm long appendage partially adnate to the base of lip. Lateral lobes ovate-lanceolate, double-folded, fringed at margin towards apex. Midlobe up to 2.5 x 6 mm, 3-lobuled; midlobule *c.* 1 mm long, triangular, acute; side lobules 1-1.2 x 1.5-2 mm, incurved and overlapping initially, later recurved revolute, oblong, obtuse. Column 10-18 mm long 2 appendages, broad, angular, carinate at base, grooved dorsally, narrowed towards apex, forked or biclawed; appendages 2, attached to base of the column dorsally and embedded along the groove, dissimilar, the upper 8-9 mm long, linear-lanceolate, obtuse and the lower 13-14 mm long, linear, strap-like or spathulate, rounded or obtuse, enclosed by the biclawed apex of the column. Pollinia absent. (Figs. 1-9).

Holotype (Gopalan 93224, CAL) and isotypes (Gopalan 93224, MH-acc. no. 157415-24) were collected at Poonkulam (1120 m) in Agastyamalai, Tirunelveli Kattabomman District, Tamil Nadu, India on 24th April, 1990. Paratypes (Gopalan 96242, MH-acc. no. 157425-26) were also collected from the same locality on 3 April, 1991.

The name *Aenhenrya* honours Dr. A.N. Henry, Scientist 'SE', BSI, for his pioneering contributions to the flora/vegetation of Agastyamalai hills.

Thanks are due to Dr. V.J. Nair, Scientist-SD, BSI, for rendering the Latin translation and Dr. N.P. Balakrishnan, Joint Director, BSI, for facilities and helpful suggestions.

GNATHIA BENGALENSIS, A NEW SPECIES OF GNATHIIDAE (CRUSTACEA: ISOPODA : GNATHIIDEA) FROM VISAKHAPATNAM COAST[1]

C. Jalaja Kumari, K. Hanumantha Rao and K. Shyamasundari[2]

(*With two text-figures*)

Gnathia bengalensis, a new species of the family Gnathiidae described from the rocky intertidal regions of Rishikonda and Gangavaram of Visakhapatnam Coast. Five specimens were collected from the sponge *Callyspongia fibrosa*. Similarities and differences with related species are illustrated.

Introduction

Monod (1926) published a valuable work on the isopods belonging to the family Ganthiidae. The genus *Gnathia* was erected by Leach in 1815, the salient features being as follow. Cephalon of male large and quadrangular; that of female rather small and subtriangular. Pereon composed of 5 well developed segments, the other two being rudimentary; the first being fused with the head and the last placed between the projecting lateral parts of the fifth segment. First pair of pereopods in males operculiform, composed of two articles and those of female subpediform being divided into 3-4 articles. Five pairs of ambulatory pereopods present. Pleon much narrower than pereon. Mandible present in males; they are more or less flattened and project beyond the anterior margin of cephalon. Maxillipeds without epigrowths and palp comprised of four articles.

In the present study, some specimens belonging to the genus *Gnathia* have been collected from the sponge *Callyspongia fibrosa*. As they differ significantly from the other related species,

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[1] Accepted January 1993.

[2] Department of Zoology, Andhra University, Visakhapatnam, Andhra Pradesh 530 003.

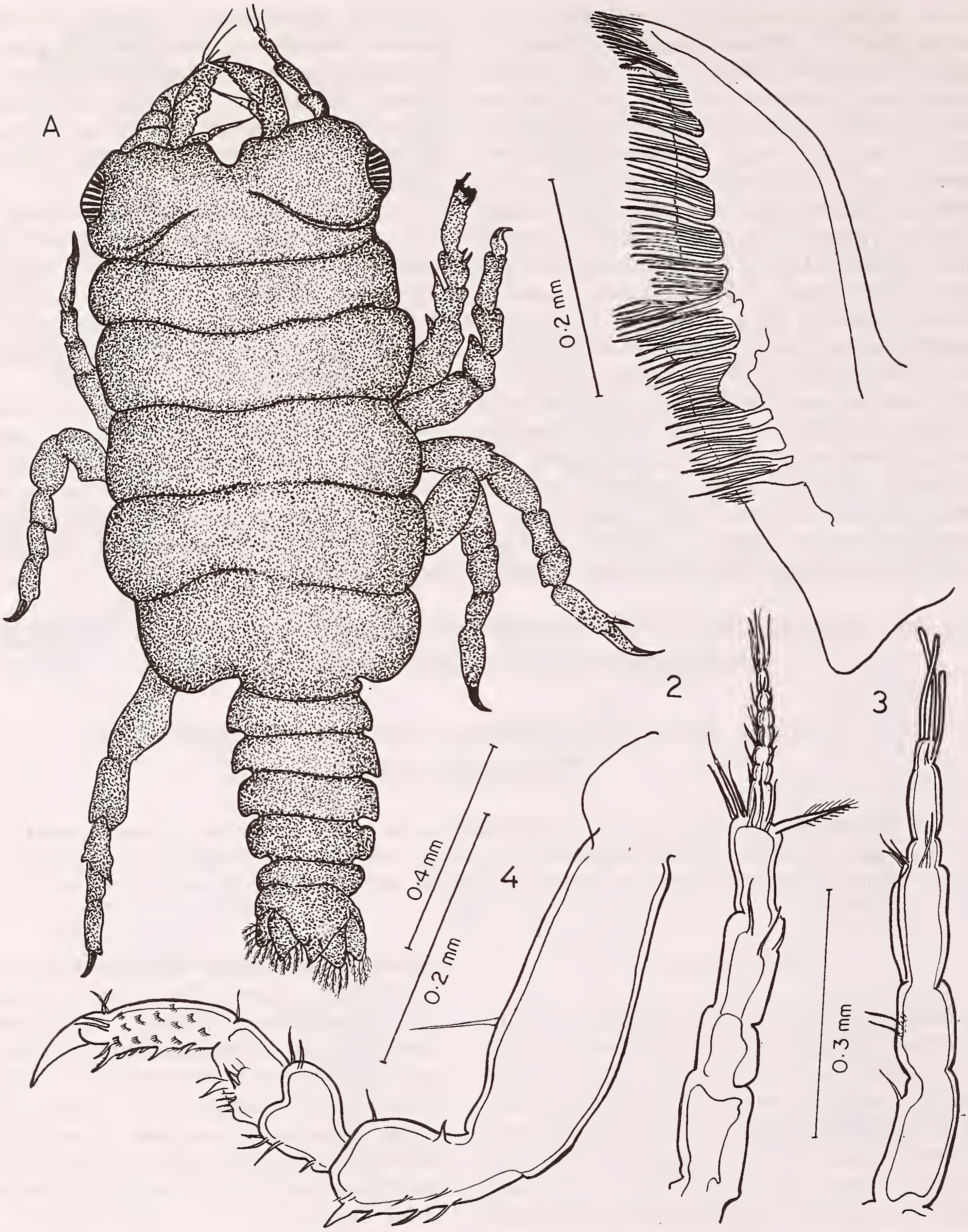
A
0·2 mm
2
3
0·4 mm
4
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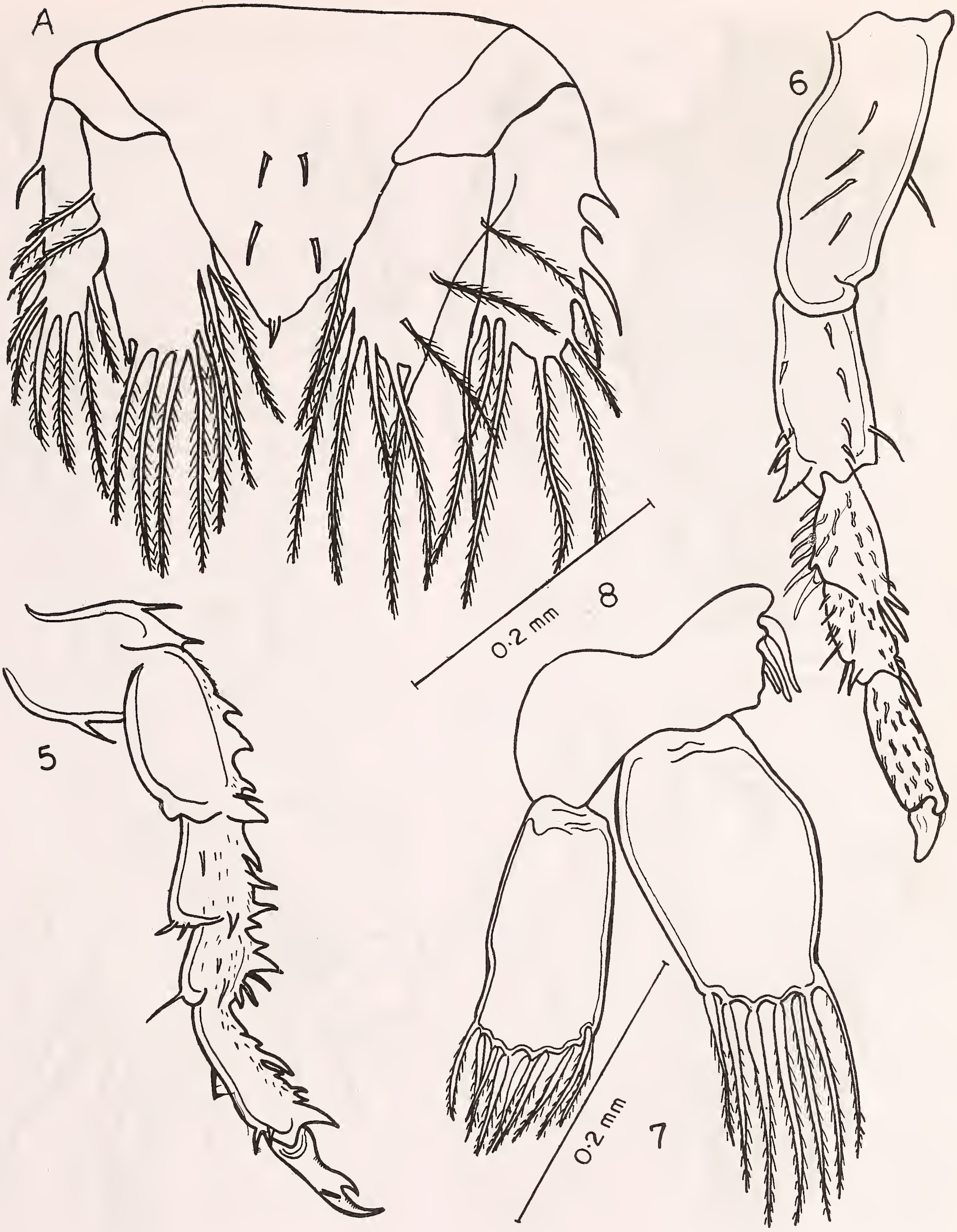
Fig. 1 : A. Male of *Gnathia bengalensis* sp. nov.
1. Mandible; 2. Antenna; 3. Antennule; 4. Second pereopod.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6
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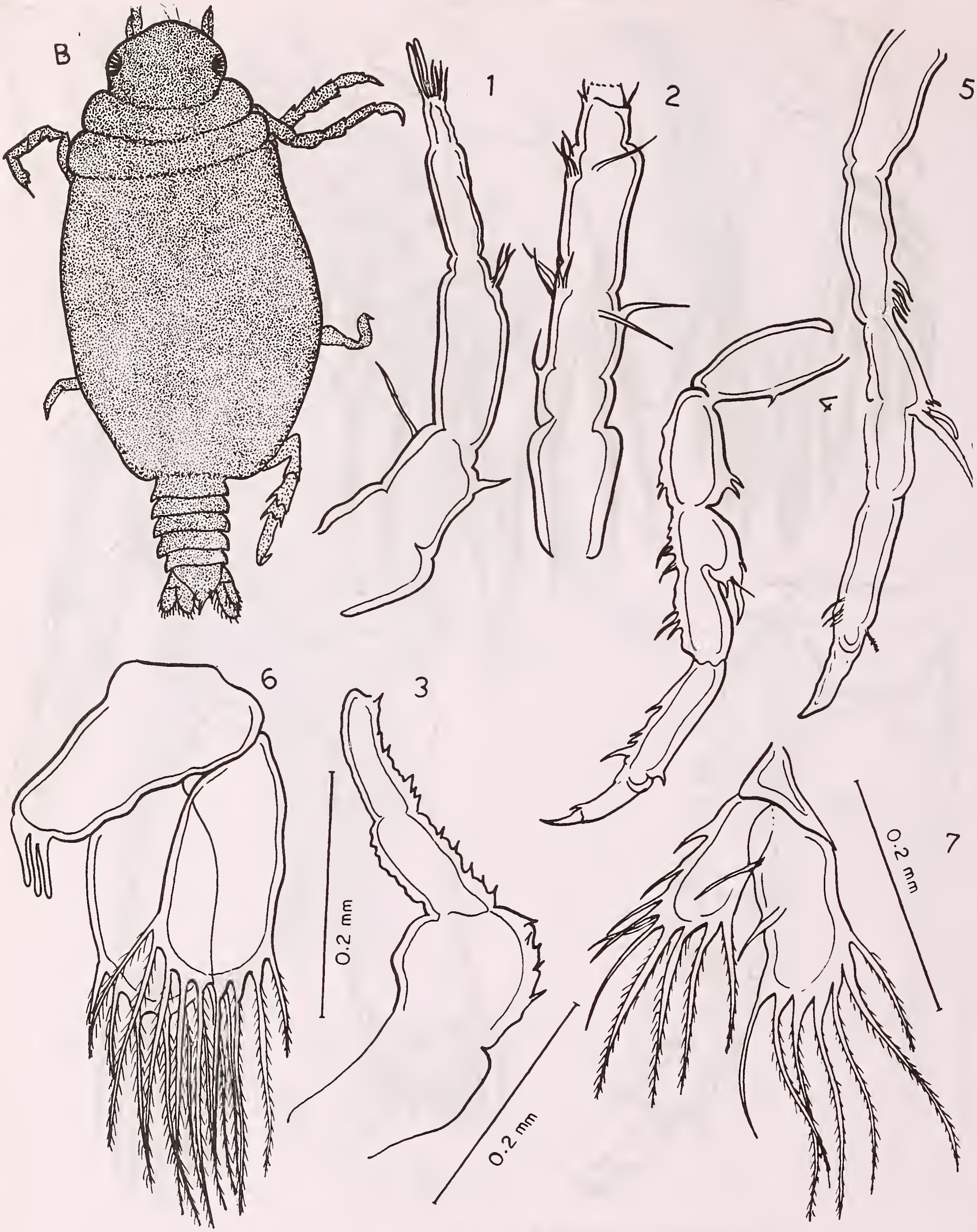
Fig. 1:A. Male of *Gnathia bengalensis* sp. nov.
5. Fourth pereopod; 6. Sixth pereopod; 7. Telson.


B
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6
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0.2 mm
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7
0.2 mm

Fig. 2:B. Female of *Gnathia bengalensis* sp. nov.
1. Antennule; 2. Antenna; 3. First pereopod; 4. Second pereopod; 5. Third pereopod; 6. Sixth pereopod; 7. Uropod.

they are described as a new species *Gnathia bengalensis.*

Gnathia bengalensis sp. nov.

MALE: Cephalon somewhat rectangular in shape. Eyes present in the mid-lateral region. Head is covered by hairs; there is a depression in the mid-anterior region. The antennule has a peduncle of 4 articles of which the basal and the third article are long and equal in length. The second article is about 3/4 the length of basal article and the fourth article is very small about 1/3rd the length of the second article. The flagellum bears 2 articles of which the penultimate article is elongated and the terminal slightly longer than 1/3rd the length of the penultimate article. Both are provided with aesthetascs; the antenna has a peduncle of 4 articles, of which the basal and the 4th article are equal in length and the third is slightly shorter than them, while the second is the shortest of all. The flagellum comprises of 7 articles and all of them are provided with setae. The mandibles are large and extend conspicuously beyond the anterior margin of cephalon. The outer margin is smooth and is bent regularly whereas the inner margin is fringed with setae. At the lower region, the inner margin is produced almost acutely, and medially it is produced only slightly.

Body is about two and half times longer than broad; the first pereonite, though fused with cephalon, can be located, the second to sixth pereonite are distinct and well defined. These segments are subequal in length, the sixth being longest; the seventh is short and narrow and can be distinquished just above the pleonites. The pereopods are ambulatory.

Pleon narrow and elongated; all pleonites equal in length, the exopods are roughly rectangular and smaller in size than the endopods, the exopods are fringed with nine plumose setae and the endopods with seven. Telson is triangular in shape and the apex has two small setae and above it two rows of setae; the uropods are longer than the telson and the endopod is longer than exopod; both are fringed with plumose setae.

Three males were collected.

FEMALE: The animal is oblong-ovate in shape, about twice as long as wide, cephalon smaller than male, it is somewhat semicircular in shape; eyes small, round, composite and located at the post-lateral angles of head. Both pairs of Antenna as in males.

The first pereonite is almost inconspicuous, since it is short and narrow. Pereon gradually becomes wider from the second segment onwards. The second and third segments are distinct but the demarcations for fourth, fifth, and sixth segments are inconspicuous. The first pereopods are 4-segmented and the pereopods are more slender than in the male and the spines and setae are less in number. Pleon is also similar to that of the male. The pleopods are roughly oval in shape and are also fringed with plumose setae. The telson is smooth throughout its length. One female specimen was obtained in the collection.

Larva: Large, elongated, but the pereon is either distended or inflated, when inflated, the fourth, fifth and sixth segments are about as broad as the third pereonite. Cephalon roughly triangular in shape, if the mouthparts are included. The frontal margin is truncate, antennules and antennae more or less resemble that of male. The mouthparts project conspicuously beyond the cephalon, maxillae are present, the eyes very large and located on the lateral side of cephalon.

The first pereonite is rudimentary and is fused with the cephalon. The second and third pereonites are short and subequal. The fourth and fifth segments are united into one extremely long segment which are not wider, at its anterior extremity almost being as wide as the preceding segment, but at its posterior extremity being almost as narrow as the pleon. The seventh segment is similar to the pleonites. The pleonites are provided with pleopods. The telson is as in the male.

Localities: The speciemens were collected from the rocky inter-tidal regions of Rishikonda and Gangavaram, Visakhapatnam.

Material studied: Three male, one female specimens and two larvae were collected from the sponge *Callyspongia fibrosa* along the rocky intertidal regions of Rishikonda and Gangavaram of Visakhapatnam coast. Holotype 1 male and paratypes 2 males + 1 female are kept in the Department of Zoology, Andhra University, Vishakhapatnam.

Habitat: The specimens were found in association with the sponge *Callyspongia fibrosa* as commensals.

DISCUSSION

The present species differs from *Gnathia coronadoensis* (Schultz 1969) in possessing eyes, the antero-frontal margin in *G. serrata* (Richardson1905) is serrated, the eyes are visible from ventral view, and the ratio of length to breadth of cephalon differs from the present form. The cephalon is longer than wide in *G. triospathiona* (Schultz 1969) unlike the present form; frontal margin of G. crenilatifrons (Monod 1926) is crenulate and the cephalon is about as long as wide; the present form differs in these characters. Eyes in *G. multispinis* (Richardson 1905) are small and surrounded by long tubercles and the animal is spiny in appearance unlike the present species. There is no rounded process on frontal margin of cephalon set above anterior border of cephalon in the present species as in *G. hirsuata* (Schultz 1969). In *G. cristata* (Schultz 1969), the frontal margin of cephalon is produced in the middle much beyond the antero-lateral angle. As the present species differs from the species mentioned in the structure of mandible and in the shape and size of cephalon, it is differentiated from the others as a new species and named *Gnathia bengalensis* sp. nov.

ACKNOWLEDGEMENTS

One of us (C.J.K) is grateful to the Council of Scientific and Industrial Research from financial assistance. We are thankful to the authorities of Andhra university for providing facilities.

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REVIEWS

1. THE CONSERVATION OF MEDICINAL PLANTS — Proceedings of an International consultation, held from 21 to 27 March, 1988, at Chiang Mai, Thailand. Edited by O. Akerele, V. Heywood and H. Synge. pp. xx + 362 (23.5 x 15.5 cm). Cambridge University Press, Cambridge, 1991. Price not indicated.

This book contains the proceedings of international consultations organised jointly by the World Health Organisation (WHO), International Union for Conservation of Nature (IUCN) and World Wide Fund for Nature (WWF). Presentations were made by 32 leading experts from various countries in their respective fields. The objectives of the consultation were to exchange views on various problems facing the availability of Medicinal Plants and to determine priorities and recommendations for action plan.

Page xvii of the proceedings contain the "Chiang Mai Declaration – Saving life by saving plants" — which affirms the importance of medicinal plants and calls on the United Nations, its agencies and member states, as well as other International Organisations, to take action for their conservation. The book contains the following broad topics:

1. The issue, 2. Science and Industry, 3. Techniques for conservation, 4. Policies for conservation and 5. Experiences and programmes, of conservation of Medicinal plants.

The book gives useful general information and glimpses of the global state of art of the medicinal plants and their conservation today.

M. R. ALMEIDA

2. ENVIRONMENT, FOREST ECOLOGY AND MAN IN THE WESTERN GHATS. By K. R. DIKSHIT. pp. i-xii, 1-213 (25 x 16 cm) with 33 text-figures. Jaipur, Delhi, 1991. Rawat Publications, Price Rs. 300/-.

The publication under review provides an excellent integrated account of the ecology of the Mahabaleshwar plateau.

The book is in three parts. Part I presents the physical aspects, climatological data and detailed analysis of soil and hydrology of Mahabaleshwar. Part II describes the forest types, floristics and palaeoecology — a reconstructed view and Part III provides various social and human aspects vis-a-vis natural environment and economic problems followed by an epilogue. The comparative situations obtaining in some parts of W. Indian hill stations in the Nilgiris are also briefly touched. It also discusses frankly the problems and conflicts suggesting probable solutions. This is followed by a fairly detailed bibliography and index.

This reviewer finds this integrated account of the environment of Mahabaleshwar to be the best so far pointing out social conflicts arising out of conservation action by the administration and nature lovers and compulsions of lack of resources of the local population. This is truly a scholarly work embodying studies of a team of students of Prof. Dikshit and his colleagues for which Dr Dikshit and his co-workers deserve our gratitude and compliments. Future workers in the ecologically fragile montane regions of the tropics, particularly the Western Ghats region will find a wealth of information in this book.

The book reviews the contemporary status of the Mahabaleshwar plateau and presents a balanced picture of problems of regeneration of nature suggesting some concrete measures and emphasising that the cooperation of local inhabitants is vital to the preservation of nature.

This book will be very useful for educational institutions and administration dealing with development and conservation of hilly districts of India where somewhat similar situations obtain. I have no hesitation in recommending this scholarly work to serious students of environment and conservation strategies.

P. V. BOLE

3. A GUIDE TO THE BIRDS OF THAILAND. By Boonsong Lekagul and Philip D. Round. pp. 457 (22 x 14 cm) with 135 colour plates and 915 range maps. Bangkok [6 Charoen Krung 36 (Soi Rong Phasi) Bangrak, Bangkok 10500, Thailand], 1991. Saha Karn Bhaet Co. Ltd. Price ?

In 1983, Salim Ali and S. Dillon Ripley's *Pictorial Guide to Birds* of the *Indian Subcontinent* was published, providing the first portable book illustrating all the birds of India; it has been a great boon to area birdwatchers, ornithologists, and tourists. As we write this, work is well underway on more informative and current field guides for the Indian subcontinent. The book under review here occupies a similar status, that of having greatly enhanced Dr. Boonsong Lekagul's previous field guide to birds of Thailand. Boonsong and Round's *A Guide to the Birds of Thailand* is without a doubt the most up-to-date, most comprehensive, and best-illustrated field guide yet available for any part of Asia. Over half of the birds found in the Indian subcontinent are depicted in this book, making it very useful here. This field guide would be a necessary buy for serious Indian birdwatchers as also for other regions of the subcontinent. Many of the montane species of northwestern Thailand also occur in northeastern India, while the birds of peninsular Thailand tend to bear affinities to those of Malaysia and Indonesia. Thailand entirely lacks deserts and very high mountains and thus most species of northwestern India and the high Himalayas are lacking. Many widespread lowland forest and open country birds are shared between the two countries, but beware of the almost inevitable racial differences in these widespread species.

Every species of bird known from Thailand is illustrated in color, as are important sexual, age, and geographic plumage variations. Introductory material in this book includes a brief history of Thai ornithology, followed by sections on geography, climate, habitat, and conservation. Other sections provide bird- watching tips, a list of relevant societies, birding localities, and hints for use of the book. A glossary, selected bibliography, and separate indices of common, scientific, and Thai names appear after the species accounts. Two appendices cover late additions to the list of birds of Thailand and possible future additions based on occurrence in neighbouring countries of some species and vagrant tendencies of others.

The introductory text and the species accounts appear to have been designed primarily for birders visiting Thailand, and an introductory stimulus that might prompt Thais to take up birdwatching or serious ornithology seems to be lacking. In contrast, the matter-of-fact *Pictorial Guide* and the educative *Book of Indian Birds* have provided the necessary direction to many Indian birders. We hope that a future Thai edition will effectively address this problem.

The front endpapers feature a novel approach to keying out families: one or a few small representative figures for each major bird group are indexed with the beginning page number of the plates for that group. The foreword is written by Ben King, an acknowledged field expert on birds of Asia, who notes that Dr. Boonsong's efforts and the first two versions of his guide "helped immensely to raise interest in the birds of Thailand, thereby kindling a desire to protect them and their habitat." The parallel to Dr Boonsong's impact in India is, of course, the tremendous influence Dr Salim Ali had in creating awareness of and enhancing the mechanism for nature conservation. Dr Boonsong Lekagul, Philip Round and Ben King have all utilized the BNHS bird collections and Dr Salim Ali arranged for loans of specimens for this field guide.

Wherever possible, this book emphasizes the necessity of conservation; Thailand has lost a great percentage of its forest, including the vast majority of lowland forest, and nearly all its natural wetlands. A number of species have become extinct or nearly so in Thailand due to destruction of habitat, while tolerant open country species have greatly prospered. Thailand's remaining forests are of global conservation importance; they are the primary range of the highly threatened Gurney's Pitta (*Pitta gurneyi*) and a stronghold of many other species. In addition, the enigmatic and elusive White-eyed River-Martin (*Pseudochelidon sirintarae*) is known only from Thailand, as is the little-known Deignan's Babbler (*Stachyris rodolphei*).

The species accounts are interleaved with the appropriate plates, but unfortunately not exactly opposite the relevant plates, and there is no reference to the plate number in the accounts, though species numbers refer to both. The maps are excellent, but neither they nor the text give any indication of extralimital ranges which would have made the book much more useful in neighbouring countries. This has been singularly lacking in field guides to the birds of the Indian subcontinent and would be extremely useful in future editions. While important geographic variation is often mentioned and/or depicted, in some species there is no indication of the range within Thailand of highly distinctive or disputed races, e.g. the race *P. r. cantonensis* of the Rosy minivet. Another substantial enhancement in the species accounts that is lacking in the *Pictorial Guide* are the voice descriptions. Most Oriental birds are clearly identifiable by their call. The literal renditions of vocalizations are very helpful but one who is accustomed to the *Handbook of Birds of India and Pakistan* misses the personal touch Dr Salim Ali so often provided with his metaphorical descriptions of bird songs.

The illustrations, by Mongkol Wongkalasin and Kamol Komolphalin, are of nearly uniformly high quality, and set a new standard of excellence for ornithological works for the Oriental region. Most are very well executed; clearly the artists have studied many of the birds in the field and worked in close consultation with the authors. This book provides the first accurate and lifelike depictions of many Southeast Asian species. We noted a few minor problems, enumerated below; more may be obvious to specialists on birds of the region. A few misinterpretations of feather structure are apparent, such as with #552, the Greater Racket-tailed Drongo (*Dicrurus paradiseus*), which is drawn with two right-hand rackets (J. Anderton, pers. comm.). In a few cases, primaries appear to overlap the wrong way (e.g. flying adults of #224 and #230), as do rectrices in others (e.g. #650, 652). Some drawings are not correctly proportioned, for example, on Plate 4, the herons' legs appear too short; #27, the Black-crowned Night-Heron (*Nycticorax nycticorax*) has an overly large bill; for #33, the Painted Stork (*Mycteria leucocephala*), the same base drawings apparently were used for upper-and underwing depictions, so the perspective is wrong for the upperwing illustrations; the neck is too long on #86, the White-bellied Sea-Eagle (*Haliaeetus leucogaster*); the bill is incorrectly shaped in 174, the Eastern Curlew (*Numenius madagascariensis*); the head of the standing Red-necked Phalarope (#193; *Phalaropus lobatus*) is too small; the flying Brown Noddy (#244, *Anous stolidus*) has a misshapen tail; the legs of #307, the Barn Owl (*Tyto alba*), are in an impossible posture; and the head shape of the Bay Owl (#308; *Phodilus badius*) is incorrect. In #472, the Nepal House-Martin (*Delichon nipalensis*), the text correctly states the throat is black but the birds are pictured with a buffy brown throat. The figure of #370, the Wrinkled Hornbill (*Rhyticeros undulatus*) shows a pure white distal tail, but this species, as with some other hornbills, often has the white portions of the tail stained chestnut, which thus may look very dark in the field (A. Sebastian, pers. comm.); the species account states these areas are "frequently stained yellowish". The variable staining of the tails in this genus has led to frequent confusion in field identification.

These criticisms are relatively minor, and detract little from the overall excellence and utility of this book. It is nearly free of careless errors, is well-designed, has a sturdy binding and good-quality paper, and is small enough to be carried easily. We have had numerous conversations with persons who have used this guide extensively in the field and in the lab, and all agree that it is of outstanding quality and utility. This book is and will continue to be invaluable for ornithologists working in Asia, as well as for travellers and conservation workers. We anticipate the day when field guides of comparable quality will be available for India.

PAMELA C. RASMUSSEN
BHARAT BHUSHAN

4. PLANTS AND HARAPPAN SUBSISTENCE: AN EXAMPLE OF STABILITY AND CHANGE FROM ROJDI. By Steven A. Weber. pp. i-xii + 200 (24 x 15.5 cm) with many figures. New Delhi, 1991. Oxford & IBH Publishing Co. Pvt. Ltd., and American Institute of Indian Studies. Price: Rs. 175/-.

This book is a scientific interpretation of the data based on excavation conducted at Rojdi, a village in Saurashtra region in the state of Gujarat. The project has conclusively revealed that the excavated remains found in Rojdi suggest their link with Nature and Late Harappan Civilisation.

The title of the book lays more emphasis on plants supposed to have been used by the then prevailing people for their daily use which have been now identified from the carbonised seeds. Methods adopted for the entire study are elaborately described in the book and interpretations of the data does not confine to only the remains of plant materials but also includes all other archaeological materials.

Although the methods adopted for studies of seeds of Original Harappan Civilisation are

Name cited	Probable species
Feronia cretica	*Feronia elephantum* or *Fagonia cretica*
Echinocarpus echinoides	*Echinops echinoides*
Graphalium luteo-album	*Gnaphalium luteo-album*
Aramannia baccifera	*Ammania baccifera*
Barleria aristat	*Barleria cristata*
Commelina neediflora	*Commelina nudiflora*
Febristylis siberiana	*Fimbristylis siberiana*
Euphorbia merifolia	*Euphorbia neriifolia*
Cyamopsis tetragmalob	*Cyamopsis tetragonoloba*

appropriate, it appears that a large percentage of materials isolated from Rojdi is contaminated with plant material from modern time vegetation. As a result of the contaminations a number of conclusions, based on available data, remain hypothetical. If we believe that scientific identifications of botanical seed materials are reasonably reliable, it is hard to understand why identifications of living plants of the region show tremendous amounts of errors and carelessness. The above corrections of the names of living plants found in the region noted on pages 36-37, may help the reader in understanding the part of the present flora of the area.

On the whole, the book provides good reading material. However the hypothesis presented in conclusions based on the plant materials identified could be confirmed in the future only if more data on the subject is available.

M. R. ALMEIDA

MISCELLANEOUS NOTES

1. ELEPHANT CALF PREDATION BY TIGER *PANTHERA TIGRIS* IN DALMA WILDLIFE SANCTUARY, BIHAR

Dalma Wildlife Sanctuary does not have any of the large cats on its list. During my stay at the sanctuary as a researcher of the BNHS Elephant Project from January 1989 to May 1992 I discovered the presence of a tiger (male) in the sanctuary for the first two years. After 1990 the tiger disappeared without any trace. The first record was of pug marks on 30 January 1989 immediately followed by a sighting at day time. Since Dalma Sanctuary does not hold any large prey species other than elephant (!) and bears the tiger started predating earnestly on the village cattle and livestock maintained within the core of the Sanctuary by the staff of a temple. On 18 March I discovered a dead and mauled male calf of elephant inside the core of the Sanctuary on the northern cooler slopes. On inspection I found that the neck was broken and claw marks all around the head. The summer ground litter around the spot was not much disturbed indicating instant death. Part of the hind leg and rump was eaten. The calf was around an year old. Male calves often have a tendency to make exploratory forays going away from the mother. In the case of Dalma elephant they have not been used to the presence of tigers for many years any where in their range. All these factors might have contributed to the killing of the calf. Very few records are available of such predation and one such account is given by C. H. Biddulph from erstwhile Cochin state in 1936 (JBNHS 39: 387- 388) under similar condition. In the case I recorded the tiger never returned to the carcass up to the time it was disposed by the forest officials a week after the discovery.

December 30, 1992 HEMANT S. DATYE

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2. OCCURRENCE OF THE LESSER FRIGATE BIRD *FREGATA MINOR* (GMELIN) IN ANDHRA PRADESH

On the 29th of July 1991, while conducting field studies on the birds of Sriharikota Island (13.45° N, 80.20°E) in south Andhra Pradesh, we observed a solitary Lesser Frigate bird *Fregata minor* soaring. The bird was sighted around 0830 hours near a casuarina belt of the island. The individual was seen at close quarters for at least ten minutes before it disappeared in a northerly direction. The long and pointed, black, streamlined wings, black, deeply forked tail and a long bill were diagnostic. The kite sized bird had a white breast and a black abdomen suggesting that it was a female.

A rare straggler in the monsoon to the Indian sea board, the species is recorded mainly on the west coast of India and once on the east coast (Balachandran *et al.*, JBNHS 83: 436-38. 1986). The current sighting is the first record for Andhra Pradesh. Due to inclement weather in the Bay of Bengal under the influence of the SW monsoon during the last week of July 1991, the bird may have straggled towards the Andhra Pradesh coast.

March 28, 1992 PRAKASH RAO
K. K. MOHAPATRA

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3. INCIDENT INVOLVING A SNAKE AND A PURPLE HERON *ARDEA PURPUREA* (LINN.)

Mohammed Nayerul Haque (1989, JBNHS 86(1): 95) reports an observation of a Purple Heron *Ardea purpurea* feeding on a Checkered keelback snake (*Xenochrophis piscator*) at Keoladeo Ghana National Park, Bharatpur. The author mentions that he could not come across any published record of Purple Heron feeding on snakes which is erroneous. However his observation of the snake species involved is noteworthy.

While giving detailed accounts on the food habits of water birds at Sunderbans, Mukherjee (1971, *JBNHS 68(1):* 37-64) reports Purple Herons showing a marked preference for reptiles especially snakes (to an extent of about 21% of their diet). The stomach contents of 70 adult Purple Herons examined by him contained snakes such as the Indian File or Wart Snake *Chersydrus granulatus* (Fam.: Achrochoridae), Striped Keelback *Amphiesma stolata*, Common Smooth Water Snake *Enhydris enhydris*, Dog-faced Water Snake *Cerberus rhynchops* (Fam.: Colubridae) and Estuarine Sea Snake *Hydrophis obscurus* (Fam.: Hydrophidae).

Incidentally, we ourselves have seen on 6 January 1991, a Purple Heron carrying away a snake from the water edge of Thailur Tank (12°36'N, 77°05' E) in Mandya District, Karnataka during the Asian Mid-winter Waterfowl Census 1991, organised by Birdwatcher's Field Club of Bangalore. However the snake species involved could not be identified.

January 22, 1992 J. N. PRASAD
13, 8th cross, 30th Main, J. P. Nagar I Phase,
Bangalore 560 078.

S. KARTHIKEYAN
24, Opp. Banashankari Temple, Shakambarinagar,
8th Block Jayanagar P.O., Bangalore 560 082.

S. SUBRAMANYA
HPHT Scheme, J Block, GKVK, University of Agriculture
Sciences, Bangalore 560 065.

4. THE WHITE STORK *CICONIA CICONIA* (LINN.) AT POINT CALIMERE, TAMIL NADU

During the Asian Waterfowl Count conducted in January 1992, I sighted a flock of eight white storks *Ciconia ciconia* —a species not listed so far in the checklist for the Sanctuary. The storks were seen in the grazing lands frequented by blackbuck.

The Asian Water Count has recorded the following numbers of white storks for Tamil Nadu: 267 in 1987, 48 in 1988, 11 in 1989, 21 in 1990, and 78 in 1991.

February 24, 1992 RANJIT MANAKADAN
Bombay Natural History Society, Hornbill House,
Dr Salim Ali Chowk, Shahid Bhagat Singh Road,
Bombay 400 023.

5. VOICE OF BLYTH'S BAZA *AVICEDA JERDONI JERDONI* (BLYTH)

Blyth's Baza or the Northern Brown Lizard Hawk is a medium-sized hawk with a conspicuous upstanding crest. It is a rare bird and is also lesser known than its southern cousin, *A.j. ceylonensis*. Its voice was hitherto unrecorded (HANDBOOK 1: 215-216).

On 5 November, 1991 I observed two birds, probably a pair, at about 9000 hrs between Langcholiet and Nailalung in Dhansiri RF (Karbi Anglong district, Assam).

They were flying in circles and also perched on the top of trees, when they were identified. While flying, one bird uttered a shrill whistle *wee-wee-wir*, etc. It was similar to that of the Pariah Kite (*Milvus migrans*) but was softer and milder. It also resembled to some extent the initial call of the Crested Serpent Eagle (*Spilornis cheela*). I again heard similar call on 10 and 24 November, about one and a half km west. On both the days two birds were seen and were calling while in flight.

January 21, 1992 ANWARUDDIN CHOUDHURY
Near Gate No. 1 of Nehru Stadium,
Islampur Road, Guwahati 781 007, Assam.

6. THE CRESTED HONEY BUZZARD *PERNIS PTILORHYNCUS* (TEMMINCK) BREEDING IN KERALA

Dr Salim Ali in his BIRDS OF KERALA (1969) says that the breeding of the Crested Honey Buzzard had not been recorded in Kerala till then. The purpose of this note is chiefly to establish the fact that this bird does nest in Kerala. I hope to publish a separate note on some aspects of the plumage, behaviour and voice of the pair I had found nesting at Kavassery, Palghat Dt., Kerala, especially because of some striking differences between my observations and published accounts such as Rishad Naoroji's in JBNHS 82: 301-305 (1985).

Although frequent encounters with the Crested Honey Buzzard in the Periyar Wildlife Sanctuary had made me familiar with the bird, most of the bird books I had read asserted that the Honey Buzzard is a bird of the hill forests and that, owing to the extreme variability of its plumage phases, it is a rather tricky bird to identify. So, when, on 25-xii-1989, I saw a pale-phase Honey Buzzard flying over a large expanse of paddy fields in Kavassery which is only some 90 m above MSL and where, apart from the Brahminy and Pariah Kites, the only large resident bird of prey is the Crested Serpent Eagle (*Spilornis cheela*), I jumped to the conclusion that this pale 'eagle' was an immature Serpent Eagle. The glimpse I got 3 days later of a dark-brown eagle with a pattern of pale and dark bands on wings and tail, served only to support my hypothesis that the pale eagle I had seen on 25- xii-1989 and, later in my own compound, was an immature Serpent Eagle.

Soon it became clear these two eagles had made a large mango tree in my own backyard their base. Fortunate though it was that the birds had taken up residence in my own compound and that a pair of Jungle Crows that had a nest in coconut tree some 150 m away, regularly gave me notice of the arrival, presence and departure of these 'eagles' with loud protests and frenzied mobbing, the dense umbrella of mango, coconut, neem and tamarind foliage that covered the compound made close observation of the birds extremely difficult. The misconception that the two eagles were immature Serpent Eagles prevented me from even suspecting that they could be nesting in that mango tree although the pale bird (which I had christened 'PE') was often seen and heard near a disused nest of the Jungle Crow situated 40 feet (*c.* 12 m) up the mango tree (named OWMT = over-the-well mango tree).

I had to be away from home for 7 months from 23-v-1990. Soon after my return on 28-xii-1990 I noted that the old Jungle Crow nest in OWMT seemed to have been appropriated by a pair of Shikras (*Accipiter badius*). 14 days later I noted PE on OWMT and heard it uttering a run of low *klwikwlikwlikwlik* notes while a vociferous flock of Jungle Crows was mobbing it. Thereafter PE was often seen in OWMT and was found spending the night on a branch of OWMT or another mango tree some 50 feet (*c.* 15 m) to the northeast of it. PE roosted on the latter on 6 consecutive days from 3-ii-1991.

Between 3-i-91 and 24-ii-91 the Shikras were often seen visiting OWMT, sometimes going to the old nest, often joining the crows in harassing PE and, on a few occasions, actually attacking PE or the dark 'eagle' (DE) which, too, visited OWMT now and then. On the 22nd and 24th of February the kwlik-wlik-wlik-wlik calls of PE (and/or DE), the shrill screams of a Shikra and glimpses of flailing wings in the nest suggested a fracas between these birds. Around 1700 hrs on the 24th my wife found on the ground under the OWMT nest two halves of a small egg (*c.* 38 x 30 mm), white with a bluish tinge, and with some yolk sticking to the inside of the larger half. This was almost certainly an egg of the Shikra, which had probably been broken, and its contents consumed, by the larger bird which seemed to have usurped the Shikra's nest.

On 7-iii-1991 at 0900 hrs a man went up OWMT to pluck mangoes and, at my request, took a look at the nest. PE had been sitting in the nest, and flew off only when the man was a few feet below the nest. It then flew round the tree two or three times alighted on another mango tree some 9 metres away and sat there quietly while the man was going up to look into the nest. The man reported that there were two large reddish eggs in the nest. One of these he lowered in his basket for my inspection. Unfortunately, the shell got slightly crushed in the process. So I decided that there was no point in returning it to the nest, and asked the man to come down as soon as possible. However, he took more than an hour to collect the remaining mangoes. Around 1015 hrs the parent bird, pursued by a rabble of crows, flew over the tree and disappeared. After that there was no sign of the nesting birds for the rest of the day and I feared that they had deserted the nest.

The egg that had been taken from the nest was almost round and measured roughly 54 x 44 mm. Its ground colour was pale buff, almost completely covered by overlapping blotches of light grey, light rusty-brown and dark reddish-brown. Hardset, it contained a well-formed, yellow-skinned, naked embryo, with a membraneous sac dangling from its vent.

It was the number of eggs in the nest and the dimensions of the egg which had been removed from the nest that served as clues to the identity of the parents. When I found that these agreed only with the description of the eggs of the Honey Buzzard, I was able to confirm the identification of the adults by following other clues such as the pattern of the bars on the tail, the vulturine profile, the rudimentary nuchal crest etc.

Between 7-iii-1991 and 8-iv-1991, though both PE and DE were seen in the neighbourhood, I seldom saw them going to OWMT and feared that they had not cared to incubate the egg left in their nest. However, on 8-iv-1991, when the mango-plucker came again, I asked him to take another look at the nest. When he was almost within reach of the nest, an adult (it turned out to be PE) flew off the nest. It went on flying in circles above the tree while the man was looking at the nest and even while he was climbing down. On reaching the nest the man had found a duck-sized white downy nestling in it. Soon after the man had reached the ground, for 45 minutes PE without leaving the perch, went on uttering very loud double *feeee-yoo's*.

Thereafter I kept a closer watch on the movements of the parents, greatly aided by the behaviour of the Jungle Crows which announced the arrival and departure of the Honey Buzzards with frantic activity and excited calls.

The nestling left the nest at 0640 hrs on 8-v-1991, flew from OWMT to another mango tree at 1732 hrs on 9-v-1991 and, 28 minutes later, to a coconut tree *c.* 15 metres away where PE was sitting. But the parent and the fledgeling behaved as though they were absolute strangers. There was no vocal greeting or any other display indicative of the parent-chick bond. The parents, PE and DE also, on the few occasions when they were close together, had behaved like strangers!

On 11-v-1991 in the evening the fledgeling flew to a coconut tree and appeared to settle down to roost on a frond. Again, on 22-v-1991 it was seen at dusk on a coconut frond and was still there at 0520 hrs on the next day.

Between 29-v-1991 and 16-vi-1991 (during which period I was away from home from the 1st to the 13th of June) although the adults were seen occasionally, there was no sign of the juvenile. But at 1330 hrs on 16-vi-1991 the juvenile was seen on a coconut tree *c.* 100 metres away from OWMT. By 1350 hrs it had disappeared and was next seen only on 7-viii-1991 when, from 0730 hrs till *c.* 0930 it went on calling *feee yoo - feee yooo* from a coconut tree at the edge of a paddy field some 50 metres to the north of OWMT. After that date, during the next 4 months no Honey Buzzard was noted in the area.

Soon after the juvenile and its parents had left the place, while engaged in gathering material for a supplement to Dr Salim Ali's BIRDS OF KERALA, I was going through the diaries of bird observations I have been keeping since 1942. In one of the volumes dealing with the birds I had watched at Chittur (Palghat Dt.) between 1958 and 1962 I found the sketch of a juvenile bird of prey that looked like a photo-copy of some of the sketches I had made of the fledgeling referred to in the first part of this note. Both these juveniles were dark brown (almost black) above, including the crown, the sides of the head covering the lores, eyes and ear-coverts, and the hindneck and the rest of the upperparts. Their underparts from the sides of the face and the chin to the under tail-coverts were pure white with blackish shaft-streaks. Both had a prominent, long, thin, graduated black crest which pointed backwards from the hindcrown. The crest remained horizontal even when the harassment by crows should have excited the juveniles. Both looked rather slim in comparison with their parents.

According to my diary, on 7-vi-1959 in a large compound full of old mango trees and coconut trees I had found a dark 'eagle' with white underparts and a backward-pointing crest being bullied by a flock of crows. It was holding in its talons the plucked carcass of a small bird or a nestling which a dark chocolate-brown 'eagle' had just given it. Although the young eagle continually uttered plaintive, metallic mewing notes, the adult remained on its perch in another tree, also uttering mewing calls from time to time. These 'eagles' spent the rest of the day in the mango grove, frequently calling to each other. On the next day also the same adult and the juvenile were in the mango grove almost all day, the adult often repeating a thin, plaintive *wheee-yooo or feee-yooo* eight to ten times. On the 9th, only the juvenile was in the grove. Although it went on uttering a low plaintive *feeeyooo-feeeyooo* no adult was seen coming near it. After the 9th neither the juvenile nor the parent was seen or heard in the mango grove.

Hindsight, in the light of my observations of 1991, makes it clear that the 'eagles' I had seen and heard at Chittur in June 1959 were a dark-phase Crested Honey Buzzard and its young one. That, therefore, may be considered the first record of the breeding of the Crested Honey Buzzard in Kerala.

The Honey Buzzards that nested in my compound at Kavassery and their nest were seen by a number of birdwatchers including R. venugopalan and Suresh Elamon.

January 21, 1992 K.K. NEELAKANTAN

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7. EASTERN GOSHAWK IN BANGALORE

On 16 November 1990, one of us (SS) was attracted by the loud shrieking calls of Drongos from within the canopy of a cashew tree (*Anacardium occidentale* Linn.) about 5 m tall at the Gandhi Krishi Vignana Kendra (GKVK; 13° 04′ N, 77°34′ E), Bangalore. As the tree located within a scrub jungle intermixed with Eucalyptus was approached, an adult Goshawk (*Accipiter gentilis* Menzbier) burst out of the canopy, followed a little later by three Grey Drongos *Dicrurus leucophaeus* Vieillot and a Haircrested Drongo *D. hottentotus* (Linnaeus). The hawk flew overhead affording a clear view of its size, closely barred underparts, banded wings and tail and a distinct white supercilium. The bird very quickly vanished behind the canopies of nearby trees and a search of the scrub in the next one hour and on two subsequent days did not reveal the presence of the hawk in the area.

Subsequently, on 1 January 1991 a subadult of the same species was observed in the Post and Telegraph compound (13°54′N, 77°35′E) of J.P. Nagar, Bangalore. The large size of the brownish accipiter with boldly streaked underparts, barred wings and a distinct whitish supercilium were unmistakable. The hawk remained in the area till 1 April 1991. It was invariably seen perched on any one of the fifteen 10 m tall poles present in the area. The area is an approximately 20 ha. open grassland partly covered with bushes and trees. A high compound wall surrounds the area to prevent human encroachment.

The Eastern Goshawk is a rare winter visitor to northwestern India and Himalayan foothills (Ali and Ripley 1987, Compact HANDBOOK). Hitherto, the vagrants seen in Victoria Park, Bhavnagar, Gujarat (Dharmakumarsinhji 1954, JBNHS 52: 211) is considered to be the southernmost record for the species within the Indian limits.

In this context, the above two sightings in Bangalore in addition to being the southernmost record, are of importance as the species has been observed for the first time in the peninsula.

While the adult observed at GKVK can be

considered as a straggler, the continued presence of the subadult for 79 days in the same locality suggests that it is a vagrant.

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8. IMPERIAL EAGLE *AQUILA HELIACA* SAVIGNY WINTERING IN SOUTH EAST RAJASTHAN

I have been observing a pair of Imperial Eagle (*Aquila heliaca*) wintering at Alniya Dam near Kota regularly for the last two winters. During the last winter, the pair was seen at Alniya from November 1990 to March 1991 and the pair returned in the last week of October 1991. As per the earlier records, the wintering area of Imperial Eagle roughly falls around 28°N latitude and 72°E longitude with a few sightings from Kutch and Saurashtra. Its regular arrival at Alniya Dam 25° 10′ N latitude and 75° 52′ longitude could mean an extension of its wintering range towards Central India. The pair seen at Kota is very easily identifiable as the Imperial Eagle. The larger bird has golden head and very prominent white scapular markings. Its smaller partner had buff head and no scapular marking. The pair remains close to each other and has been observed sitting on the island or a tree stump for hours together. Recently, some fresh and large pellets were found near the tree, where the pair had roosted. The pellets were formed of breast and abdominal feathers of Barheaded Goose (*Anser indicus*). This could be a case of active predation by Imperial Eagle as there is no other large predator in the area, which could have been robbed of its booty.

January 21, 1992 RAKESH VYAS
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9. PAINTED SPURFOWL *GALLOPERDIX LUNULATA* (VALENCIENNES) IN SARISKA TIGER RESERVE, RAJASTHAN

On the morning of 12th November, 1987 I saw a painted Spurfowl (*Galloperdix lunulata*) near Pandupole temple in the Sariska Tiger Reserve, Rajasthan. During my two years stay in Sariska from July 1988 to July 1990, I have seen Painted Spur-fowl all over Sariska in rocky areas including disturbed places like the buffer areas and temples. Females with chicks were also seen twice during August, 1988, just after the rains.

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10. THE COOT *FULICA ATRA* LINNAEUS BREEDING FURTHER SOUTH IN THE INDIAN PENINSULA

On 17th October 1991, on our way to Kerala, our train stopped for a while probably for a signal around 3 O' clock in the afternoon, approximately 3 km north of Kazipet Junction, Andhra Pradesh. The railway track here intersects a vast wetland. The fringes of this wetland towards the track is occupied by *Ipomoea carnia.* We could see a number of aquatic birds and were astonished to see an adult

Coot (*Fulica atra*) with two chicks about 25 metres away from our train. This sighting made us look for more chicks but our quick search for about 10 minutes was not rewarded. By then the train started moving.

There are only a few records of the Coot breeding in the Peninsula. Khacher (1977, JBNHS 73: 525) has recorded Coot chicks from Nasik in Maharashtra. Nests were reported by Fr. J. Hernandes (Navarro 1980, JBNHS 77: 137) from Khandala (Poona) and from Bhavnagar in Gujarat by Dharmakumarsinhji (1947, JBNHS 46: 724) However, to our knowledge there is no record of their breeding further south of Maharashtra. Ali and Ripley (1983, HANDBOOK Birds) state that the coot breeds sporadically in peninsular India during July-August and that in south India the season is in November-December.

For the last few years, we have been observing during our journeys to south India, a large number of Coots wintering in this area. Even in summer a few (5 to 10) were seen. However this was the first time we saw the coot with chicks.

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11. ON A POSSIBLE SIGHT RECORD OF THE LITTLE GULL *LARUS MINUTUS* PALLAS IN ARUNACHAL PRADESH

The Little Gull (*Larus minutus*) has been recorded as an accidental vagrant in India (HANDBOOK 3:, 37). Stray records are available from Ladakh (specimen), Bombay and Rann of Kutch (both possible sight records).

On 17 March, 1991 I made a field survey of D'Ering Memorial Wildlife Sanctuary (formerly known as the Lali Sanctuary) in West Siang district of Arunachal Pradesh to assess the migration pattern of water fowl. The sanctuary is located on the Assam border and encloses some *chapories* (sandy islets and tracts) of the Siang or Brahmaputra river (sometimes called the Lali also) and adjacent water area.

At about 1300 hrs I came across a small gull with the following characteristics: upperparts grey, under parts white; underwing dark greyish (blackish, etc.) and a conspicuously black bill. In fact its black bill generated curiosity in me to observe it. Since it was in flight and I was on a motor boat, further details like colour of legs and feet, and tail could not be recorded. However, as far as I remember the tail was white. It was, in all probability a little gull.

January 21,1992 ANWARUDDIN CHOUDHURY
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12. RECENT SIGHTING OF BLUEBEARDED BEE-EATER *NYCTYORNIS ATHERTONI* (JARDINE & SELBY)

On 3 February 1991 while surveying the Madeshwara Range Forest (12°41' N, 77°39'E; 952 m above MSL) situated about 38 km southwest of Bangalore, we were resting on a boulder in the middle of a dry streambed when we observed a pair of Bluebearded Bee-eater *Nyctyornis athertoni* (Jardine & Selby) approaching us. The birds flew along the streamside vegetation dominated by *Terminalia arjuna*, *Terminalia bellerica*, *Syzygium* sp. and *Dendrocalamus strictus*. They perched about 30 m from us and started calling. We observed them making aerial sallies after insects from the top of the trees. Later a third individual was seen about 250 m further downstream which was also calling.

Jardine and Selby (1830, ILLUSTRATIONS OF ORNITHOLOGY 2: 58) describe the species collected by Lieut. J. Atherton from Bangalore. Later Norman B. Kinnear assigned Bangalore as the type locality for the species (1925, *Ibis 12(1):* 751-753). Interestingly there has been no record of the species being sighted close to Bangalore in the later years. Even Salim Ali (1943, JBNHS 44: 9-26) did not come across this species in the neighbourhood of Bangalore during his survey of the birds of Mysore. Hence we hold the present sighting to be significant as it happens to be the only recent sighting of the species after a period of 161 years from the locality where it was first obtained.

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13. SIGHTING OF BLACK BULBUL *HYPSIPETES MADAGASCARIENSIS* (P.L.S. MULLER) IN GAYA, BIHAR

The Black Bulbul *Hypsipetes madagascariensis psaroides* Vigors is said to reach the foothills in winter, locally entering the adjacent plains, seldom as far as Delhi (Ripley, SYNOPSIS, 1982 citing Trevor Price, JBNHS 69: 651). That it enters the plains much more south of Delhi in extreme winters is brought out by the fact that one was sighted on the outskirts of Gaya (24°49'N, 85°01'E), Bihar on 18th January 1989. It was in a *Bombax ceiba* grove on the western bank of the River Phalgu. The bird was actively feeding on the nectar of the flowers and hawking insects by aerial sallies uttering an *ainch* call as it moved from one branch to another.

December 24, 1991 RASHID H. RAZA
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14. FRUIT EATING BY SUNBIRDS OF THE GENUS *NECTARINIA* IN SRI LANKA

In most literature and in general opinion, the food of Sunbirds consists of nectar, small spiders and insects. Fruit is not mentioned, nor has it been noted in stomach contents.

Observations made by me at the Yala National Park in the south- east of Sri Lanka from the 1st to the 6th of June 1991 clearly establish fruit (berry) eating as part of the diet of all three species of Sri Lankan Sunbirds, namely the Purple-rumped (*Nectarinia ceylonica ceylonica*), Loten's (*N. lotenia lotenia*) and the Purple (*N. asiatica asiatica*).

At the time several large Mustard trees (*Salvadora persica* – Sapotaceae – Sinhalese *Malitan*, Tamil *Uvai*) in the vicinity of the Yala visitors' bungalow were profusely flowering and fruiting. The Mustard tree is so named because its edible berries and to a lesser extent other parts, taste strongly of mustard when chewed. The twigs and roots are used as tooth-brushes, hence the other popular name 'Toothbrush tree'. It is a common tree in many parts of the Yala National Park and generally of open areas in the Dry and Arid Zone of south-eastern Sri Lanka. It grows to about 4 or 5 m in height, has drooping leaves and branches in a dense crown, and loose hanging inflorescences are formed in leaf axils at the end of the branches; on dunes the tree is prostrate. At the time of the observation flowers and fruit in all stages of development were present. The flowers are tiny greenish-yellow stars, the fruits when ripe are purplish-red, smooth round berries about 4 mm in diameter, with a thin skin; they taste sweet with a strong mustard tinge. These berries are said to be rich in oil, particularly benzyl mustard oil, and the seeds are said to yield 45% fat.

Between about 7 and 8 a.m. the trees attracted considerable numbers of birds, most of which on close observation proved to be Sunbirds, mainly Purple-rumped, but also Purple and Loten's. Naturally I first thought they were visiting the flowers of the trees, but soon saw that all were vigorously grabbing the ripe fruit between the mandibles, pulling them off the stalks and swallowing them whole. The birds did this in upright, horizontal or hanging positions.

Most of the Sunbirds were females and juveniles (especially of the Purple Sunbirds), but males of all three species also ate berries. Other birds also visited the trees to eat the berries, though in much smaller numbers; there were Red-vented Bulbuls (*Pycnonotus cafer haemorrhousus*), White-browed Bulbuls (*Pycnonotus luteolus insulae*), Ioras (*Aegithina tiphia multicolor*), Green Imperial Pigeon (*Ducula aenea pusilla*), Orange-breasted Green Pigeon (*Treron bicincta leggei*). Whilst individual Sunbirds would stay in the trees for several minutes, gobbling down berries in quantities, the other species remained only briefly and flew away after eating a few fruit.

Several months after recording the above observations in the Ceylon Bird Club Notes (June 1991), I came across a paper by Lambert (1991) in *Ibis*, 133: 425-426, entitled 'Fruit eating Purple-naped Sunbirds, *Hypogramma hypogrammicum* in Borneo'. Lambert's report is chiefly based on seed found in faeces of birds caught in a mist-netting programme, mainly seeds of a small tree *Poikilospermum suavolus* (Urticaceae). He states that in *Poikilospermum* spp. the seeds are contained in a structure which is essentially very flower-like. He subsequently also observed a few birds feeding on these flower-like fruits (*achenes*), as well as on fruits of *Dillenia excelsa* which also look like flowers. We have here then more a case of flower eating rather than fruit eating; only on one occasion was a Purple-naped Sunbird observed by Lambert eating the succulent fruits of *Callicarpa longifolia*.

As a matter of interest it may be mentioned here that *Nectarinia* Sunbirds eat flowers. Ali and Ripley mention that Purple Sunbirds are fond of the fleshy blossoms of *Madhuca indica* and I have observed Purple-rumped Sunbirds to eat and feed to their young the whole corolla of Bougainvillea flowers. Lambert refers in his paper to some other reported cases of fruit eating by Sunbirds in southern Africa, e.g. *Nectarinia chalybea* and *N. afra* probing over-ripe *Ficus* spp. and grapes, a liquid diet more akin to nectar feeding. Only Olive Sunbirds (*N. olivacea*) and the Collared Sunbirds (*Anthreptes collaris*) are known to eat whole fruits, including seeds (Skead 1967 ref. in Lambert) in Africa, according to Lambert.

There appears to be very little evidence in the literature of true fruit eating by Sunbirds, and this observation in Sri Lanka is exceptional in that three species of *Nectarinia* were found to feed massively on the berries of a particular tree.

March 6, 1992

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15. PATTERNS OF NEST BEAUTIFICATION BY BLACKTHROATED WEAVER BIRD *PLOCEUS BENGHALENSIS* (L.) IN EASTERN RAJASTHAN

(With three text-figures)

The Blackthroated Weaver bird, *Ploceus benghalensis* (L.) utilises various types of yellow or variants of yellow adornment to beautify its nest (Sharma 1985, 1986 a, b). Cocks of *Ploceus benghalensis* have been reported to add yellow, orange, crimson and scarlet flowers and/or flower petals of *Lantana**, *Lagerstroemia** to beautify their nests (Ambedkar 1972, Ali and Ripley 1983, Mistry 1988). Male *Ploceus benghalensis* seems inclined towards the colour yellow as exhibits for luring hens to accept the nest. A common form of display, which consists of its alighting a few centimetres from the female on a more or less horizontal arching reed stem, bowing low so that its bill points to the ground and its golden crown is presented to the prospecting female (Ali and Ripley 1983). Sometimes, while exhibiting this display, the cock may present a flower petal to the hen (Ambedkar 1972).

A few experiments conducted by Sharma (1986 a), prove the affinity of male *P. benghalensis* to yellow or its variants.

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*Species not quoted in original papers.

Type of beautification: Various types of beautification patterns are adopted by *P. benghalensis* to beautify its nests. Few forms of nest beautification observed in Eastern Rajasthan are summarised below:

(A) *Beautification in relation of nest surface:*

Depending upon the surface of the nest, used to keep the beautifying objects, two types of beautification processes may be recognised:

(i)Exo-beautification,and (ii)Endo-beautification.

Exo-beautification: In this type of beautification, aesthetic objects are kept on outer surface of the nest, especially on the roof. Such type of decoration is generally done at the post-acceptance stage of the helmet, i.e. on completed and accepted nests. Sometimes it may be initiated at the pre-acceptance stage also (Fig. 1).

Endo-beautification: In this type of beautification, the target surface is the egg-chamber interiors, especially the edge of the chamber. Internal decoration is done in helmets at pre-acceptance stage only (Figs. 2 & 3). As soon as a helmet is accepted by a prospecting female, it is completed hurriedly by the cock to install her; once a hen is installed in the completed nest, there is no further internal decoration.

(B) *Beautification in relation to plastering material:* Aesthetic objects may be kept with or without prior use of wet substance(s) like cattle dung, human excreta etc. Depending upon use of such pasting materials, two types of beautification were observed.

(i) Wet-beautification, and (ii) Dry-beautification.

Wet-beautification: In such type of beautification a certain amount of wet dung or human excreta is pasted on potential sites of the nest, before placing the floral material. In other words, floral materials are kept on a wet bed or pasting substance(s) (Fig. 2).

Dry-beautification: In such type of decoration, floral materials are implanted in the nest without placing a pasting bed below them, i.e. aesthetic objects are inserted directly between fibres. Two sub-types of dry-beautification were identified:

(i) Absolute dry-beautification, and (ii) Displaced dry- beautification.

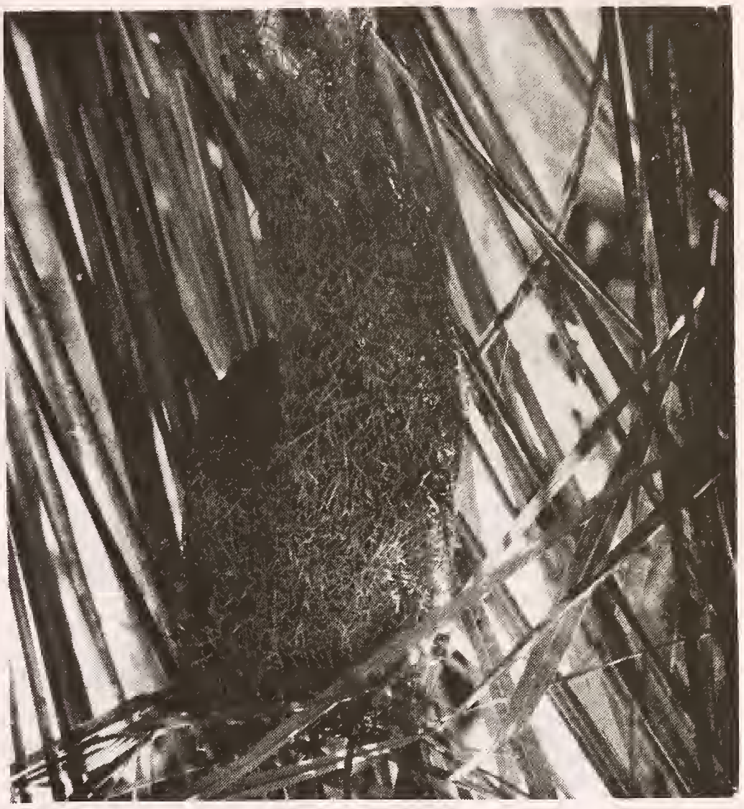

Fig. 1. Completed nest of *P. benghalensis* (L.) Ray florates of *Tagetes putula* are used as beautifying material.

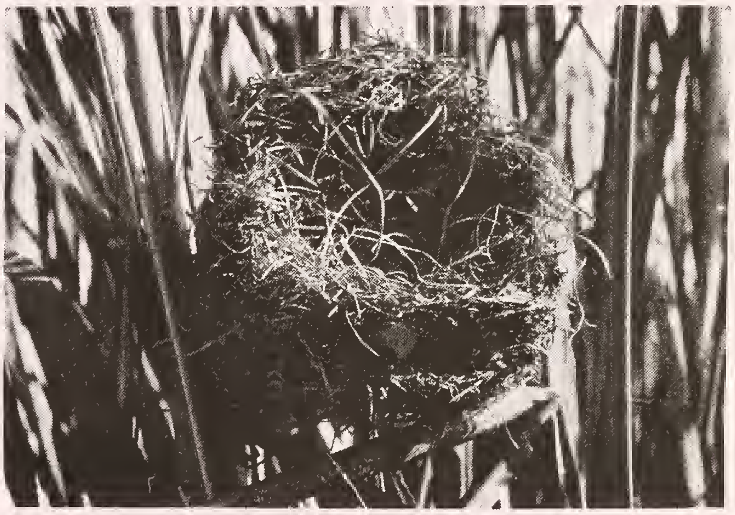

Fig. 2. Half built nest of *P. benghalensis* (L.). Two complete heads and a piece of head of *Acacia nilotica* s.sp. *indica* are used as beautifying material. (Chin-strap is not shown in fig. It was cut thrown by cock itself; nest is not placed at its original site).

Absolute dry-beautification: When pasting materials are not used at all at any stage of nest construction and floral objects are placed at suitable points of nest (Figs. 1 & 3).

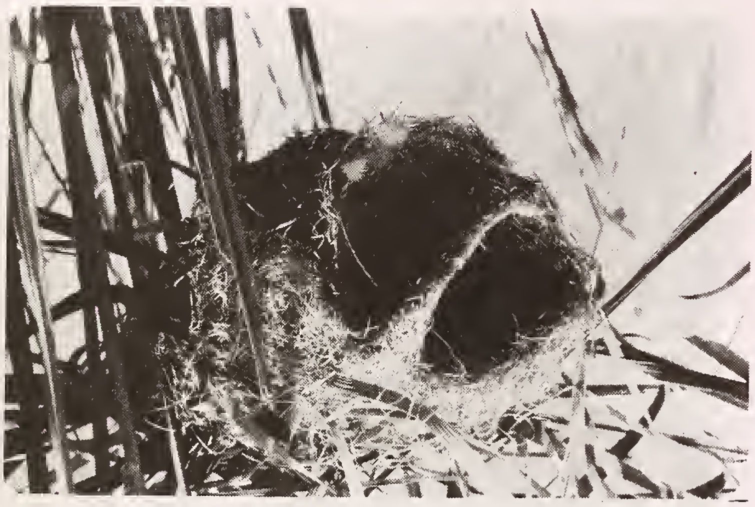

Fig. 3. Half built nest of *P. benghalensis* (L.) Three complete, fresh heads of *Acacia nilotica* s. sp. *indica* are placed at edge of egg-chamber.

Displaced dry-beautification: In such type of beautification though pasting material is used but floral objects are placed away from them. This behaviour is very strange. Possible reasons for this are being dealt with in a separate communication.

(C) *Beautification in relation of contents used:* One to many species of plants may be tapped to get floral materials for nest decoration. Keeping the contents in view, two types of beautifications may be distinguished:

(i) Mono-specific beautification, and (ii) Poly-specific beautification.

Mono-Specific Beautification: In this type, aesthetic objects, applied on individual nests are taken from one or many plants of the same species. In other words all the aesthetic objects are of 'mono-specific' origin (Figs. 1, 2 & 3).

Poly-specific beautification: This is a rather complex pattern of beautification in which floral materials from more than one species are taken for nest decoration.

(D) *Beautification in relation of nest acceptance:* Beautification activities by males commence at two different stages of the nest construction. Based on Chronology of various stages, two types of beautification may be categorised:

(i) Pre-acceptance beautification or Primary beautification, and (ii) Post-acceptance beautification or Secondary beautification.

Pre-acceptance beautification: When a nest under construction, reaches the helmet stage (yet to be accepted by a female), certain floral materials may be applied to it. Such type of beautification of nests, prior to approval of a hen, may be called pre-acceptance beautification (Figs. 2 &3).

Post-acceptance beautification: As soon as a helmet is accepted by a prospecting hen, the cock proceeds towards completion of the nest in order to install the approving female. At this stage, except weaving, neither internal deposition nor internal beautification is practised. As soon as the helmet completed, the hen occupies it to lay eggs and to raise offsprings. Sometimes such engaged completed nests also may be decorated externally by the cock. This second round of beautification may be termed as post-acceptance beautification (Fig. 1).

ACKNOWLEDGEMENTS

I am very grateful to the Late Dr. Salim Ali, for encouragement and guidance to conduct the study. I also express my sincere thanks to Dr Shiva Sharma and Dr Prabhakar Joshi, Department of Botany, University of Rajasthan, Jaipur, for encouragement and laboratory facilities provided by them.

February 2, 1992

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16. NEST BEAUTIFICATION BY *PLOCEUS BENGHALENSIS* (L.)

In some of my earlier notes, I have recorded the flowers of *Momordica dioica* as one of the nest beautifying objects preferred by Blackthroated Weaver Birds (*Ploceus benghalensis*).

The voucher specimen on verification at RUBL herbarium were found to be of *Momordica balsamina* and not *Momordica dioica*. The correction then applies to all the notes published by me.

1. Use of wet dung in egg chamber of half built nest by the Blackthroated Weaver Bird. *J. Bombay nat. Hist. Soc. 82(3):* 661- 64.

2. Plucking of male flowers of *Momordica dioica* by the Blackthroated Weaver Bird *Ploceus benghalensis. J. Bombay nat. Hist. Soc. 83(1):* 210-11.

3. Colour selection by the Blackthroated Weaver Bird *Ploceus benghalensis. J. Bombay nat. Hist. Soc. 83. (Suppl.):* 214-16.

Necessary corrections may be made and where plant *M. dioica* figures, it is to be taken as *M. balsamina*. I regret the error.

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17. ON THE BREEDING OF THE GREEN CALOTES *CALOTES CALOTES* (LINN.)

During my stay at Yercaud as part of the Indian Tree Shrew Project funded by World Wildlife Fund – US through World Wide Fund of Nature - India (Tamil Nadu State Office) a dead specimen of Green Calotes *Calotes calotes* killed by boys was obtained. The boys claimed that it was seen on a coffee bush in the coffee plantation.

The specimen measured 557 mm in total length of which the tail was 437 mm. Five fully formed white eggs were exposed through the torn sides.

The Green Calotes has been recorded from the Shevaroy hills earlier (Smith 1935). Murthy (1985) writes that the species breeds in September while Prasad and Jayanth (1991) record the breeding of the species in May. The present observation of a gravid female in April further extends the breeding period of the species.

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18. FEEDING ECOLOGY OF *PSAMMOPHILUS BLANFORDANUS* (STOLICZKA)

In the present study food habits and feeding activities of the rock lizard *Psammophilus blanfordanus* (Stoliczka) are described. It is distributed in Central India and Eastern and Western Ghats and inhabits rocky hills. They were studied under field conditions in the Eastern Ghats of Visakhapatnam district.

P. blanfordanus were observed for 22 days and many were collected to examine their stomach contents. Immediately after the capture of the

TABLE 1

ANALYSIS OF THE STOMACH CONTENTS OF THE ROCK LIZARD, *Psammophilus blanfordanus*

Food type	% Weight of the total stomach (g)	Weight of the total stomach contents	N (Stomachs)	Mean weight/ stomach contents (g)
Insecta				
Termitidae	12.47	29.43	58	0.50
Pentatomidae	1.83	4.30	38	0.11
Lygaeidae	3.06	7.20	12	0.60
Lepidopteran larvae	6.36	15.00	74	0.20
Coccinellidae	2.70	6.38	12	0.53
Corabiol grubs	5.10	12.03	7	1.72
Formicidae	28.51	67.26	74	0.91
Vespidae	2.43	5.72	21	0.27
Apidae	00.88	2.08	15	0.14
Syrphidae	1.48	3.50	4	0.87
Mollusca				
Snails	6.84	16.11	7	2.30
Sauria				
Mabuya sp.	3.63	8.56	2	4.28
Plants				
Vegetable material	13.14	31.00	27	1.15
Unidentified	11.57	27.29	31	0.88

animals, the live specimens were first anesthetised with chloroform (10%), after which the stomachs of each was removed and preserved in 3% formalin for further examination. In the laboratory, stomachs were cut open along their greater curvature and contents were dabbed with a blotting paper and the contents weighed. The contents was transferred to a petri-dish containing water and examined under a dissection microscope for identification. After identification the stomach contents were separated and preserved in 70% alcohol in labelled tubes. Food preferences of *P. blanfordanus* were determined on the basis of stomach contents analysis. Identification was made in the Department of Environmental Sciences, Andhra University, Waltair. The rock lizards are active during summer and rainy seasons while their activity is limited to very few hours during winter.

P. blanfordanus is mainly insectivorous and feeds on various types of insects and on some occasions on snails and small skinks. The analaysis of the stomach contents of *P. blanfordanus* identified twelve types of prey species. Of these ten were insects while the other two were snails and skinks.

A total of 74 stomachs were examined from which 236 g of stomach contents was obtained. Plant materials and unidentified parts of the stomach contents together constituted 24.7% of the total. Formicidae accounted for 28.5%, of the total stomach contents and family Termitidae accounted formed 12.47%.

Formicidae and lepidopteran larvae appeared in all the 74 stomachs while Termitidae was observed in 78.38% of stomachs examined. In two stomachs skinks of the genus *Mabuya* were noted (Table 1). The feeding activity of *P. blanfordanus* was in two phases.

The major one of four hours duration was between 0700 and 1100 h. The afternoon phase was very short and commenced from 1530 h and ceased by 1700 h. The presence of plant material in the stomach contents of rock lizards was perhaps due to accidental ingestion which their feeding on Lepidopteran larvae.

February 27, 1992

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19. FEEDING ECOLOGY OF *AMPHIESMA STOLATA* (LINN.)

The food habits of *Amphiesma stolata* (Linnaeus) the striped keelback collected in the environs of the Andhra University campus were studied in the Laboratory.

The food and feeding habits of *A. stolata* were investigated by verifying field observations with examination of the stomach contents.

Food preferences of *A. stolata* were determined on the basis of stomach contents. Identification was made in the Department of Environmental Sciences, Andhra University, Waltair.

The striped keelback *A. stolata* is largely aquatic prefers rice fields, grasslands and shrubby areas near fresh water bodies like ponds, lakes, and canals. It shelters in burrows in termite nests etc. *A. stolata* is diurnal and the activity between 0600 and 1800 h.

A. stolata is carnivorous and preys upon any animal that falls within its prey size range. An analysis of stomach contents and occasional direct observations in the present study indicated that toads and frogs rank first in importance in the diet. 28.76% of the total stomach contents by volume were frogs and 12.28% were toads (Table 1). Other food eaten by these snakes include insect larvae, grasshoppers, scorpions, fishes, frogs, toads, skinks and blind snakes.

The stomach contents obtained from 68 snakes were examined and eight types of animal food were recognised excluding vegetable material, unidentified materials and sand particles. The last three together constituted 16.33% of the total stomach contents (Table 1).

Feeding took place in two phases. In the morning *A. stolata* commenced foraging from 0730 hr and continued for a period of two and a half hours. The evening foraging period commenced from 1700 hr and ceased by sunset. After each feeding phase the snakes become inactive and retired to the nearest shelter available to them.

A. stolata drank water in considerable quantities, mostly during the late afternoon. In captivity they showed tolerance to starvation and 37% of captive snakes between 300 and 450 mm SVL showed no loss in weight after six days. Later on, an average weight reduction of 12.7% was observed by the 15th day.

The present study reveals that 41% of total stomach contents were frogs and toads of which frogs were twice the number of toads. It was reported earlier that toads alone account for 64% of the total stomach contents (Parhi 1983).

All the adult snakes showed considerable tolerance to starvation stress and for the first six days the loss in weight of individuals was negligible. This indicates that *A. stolata* can survive stress conditions, especially when their prey species

TABLE 1

ANALYSIS OF THE STOMACH CONTENTS OF THE STRIPED KEELBACK *A. stolata*

Food type	% weight of the total stomach contents (g)	weight of the total stomach contents	N (stomachs) contents	Mean weight/ stomach (g)
Insect larvae	5.26	25.03	16	1.56
Grasshoppers	4.00	19.04	9	2.12
Scorpions	7.16	34.08	20	1.70
Fishes	10.23	48.69	11	4.42
Frogs	28.76	136.89	36	3.80
Toads	12.28	58.45	9	6.49
Skinks	7.61	36.26	6	6.04
Typhlops	8.37	39.84	14	2.84
Vegetable material	2.56	12.18	42	0.29
Sand particles	3.52	16.75	28	0.60
Unidentified	10.25	48.79	43	1.13

are less in number or not available for a considerable length of time. However, after 15 days the loss of weight increased rapidly and the snakes avoided all activity.

December 27, 1992
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20. ADDITIONAL MARKINGS ABOVE HOOD MARKING IN INDIAN (BINOCELLATE) COBRA, *NAJA NAJA NAJA*

(With a plate)

In some of the binocellate cobra from Mangalore area additional markings on the hood have been observed. The usual hood marking of the binocellate cobra on dorsal side shows a connected pair of rings. A 'U' shaped marking connects the rings.

Some of the binocellate cobra from Mangalore have markings similar to "eyebrows" in shape over the spectacled marking. These additional markings could be clearly seen in the figures given below.

In Plate, Figure 1, two spots above the spectacled mark can be seen. In Figure 2, a twisted bar shaped marking appears above the spectacled mark.

Eye lid shaped additional marking above the spectacled mark is very conspicuous in Figure 3. Further, the spectacle mark extends on both the sides, away from the two inner black spots, till the edge of the hood. In the same specimen, black lines across the body also could be seen.

In Figure 4, the additional marking is a continuous line and in the shape of a cycle handle bar.

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21. LENGTH RECORD OF THE COMMON WOLF SNAKE *LYCODON AULICUS* FROM THE SHEVAROYS

A common wolf snake *Lycodon aulicus* was caught under interesting circumstances on a sunny morning, 17 March 1992 at 0840 hrs, at the edge of a coffee plantation near Yercaud. My attention was drawn to a sound from a heap of dry leaves. At first only a reptile's tail was seen followed by a short silence. Then, considerable rustling, a snake rolled out of the heap of leaf litter.

The snake was seen to be struggling to retain its grip on a large Common Skink *Mabuya carinata*. The snake had coiled around the skink and held its head under its coiled body. The snake was identified as the Common Wolf Snake *Lycodon aulicus.*

At this instance, red ants *Oecophylla smaragdina*, bit the snake. In a bid to rid itself of the ants lost the snake its grip on the skink which escaped. The snake was very lethargic and was captured.

The snake's identity was confirmed using Smith (1935) and measured. The total length was 820 mm and the tail 110 mm. The maximum length according to Daniel (1983) is 765 mm, Smith (1935) 760 mm and according to Whitaker (1978) 800 mm. Hence this is a record length for the species.

Though the behavioural aspects mentioned by Daniel (1983) tallies with that of the individual caught, the fact that the snake was active at 0840 hours on a bright sunny summer morning is interesting. Or did the snake just take a prey which ventured close to its hiding place and emerged due to the red ants?

This note is an offshoot of the Tree Shrew Project funded by World Wildlife Fund - US through World Wide Fund for Nature - India (Tamil Nadu State Office).

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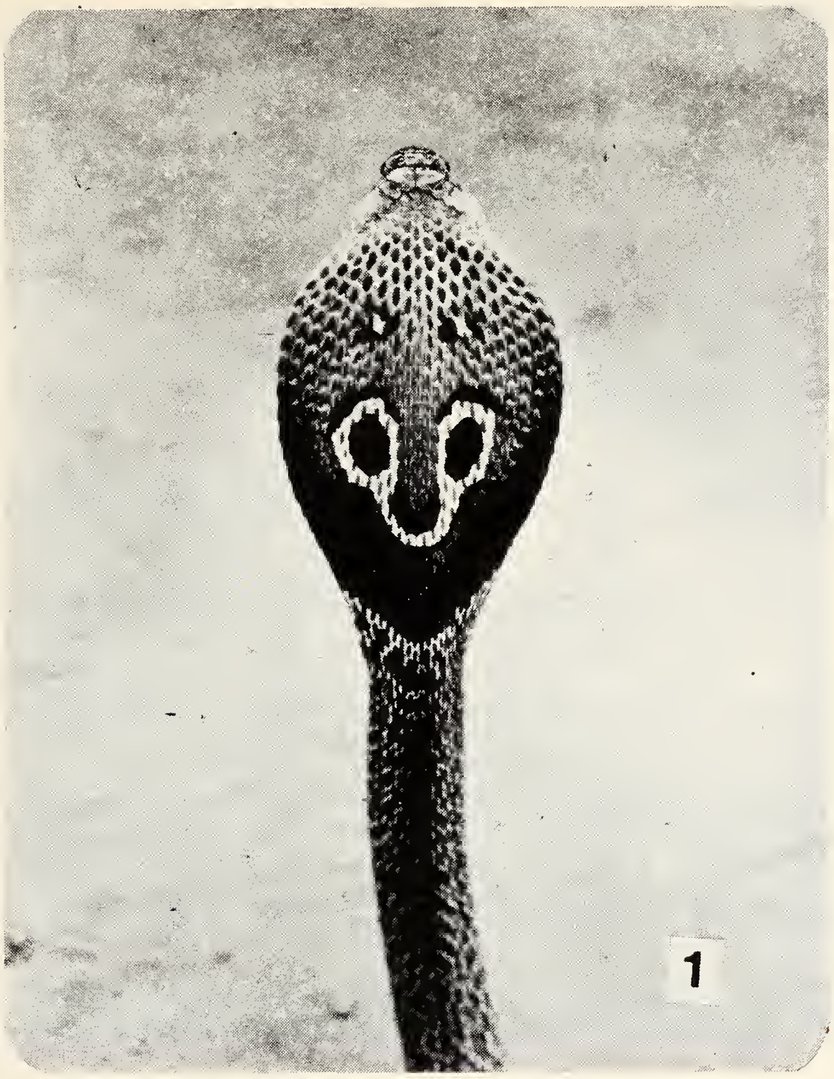
Addoor: Hood marking in *Naja naja naja*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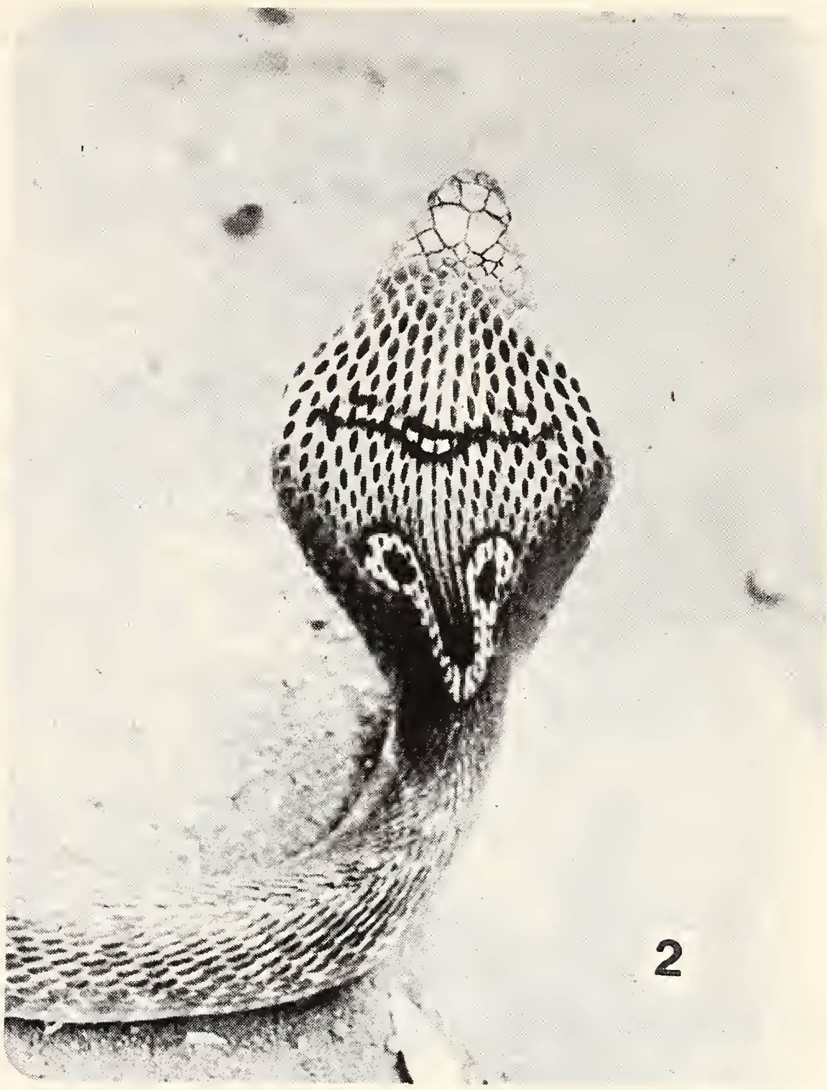
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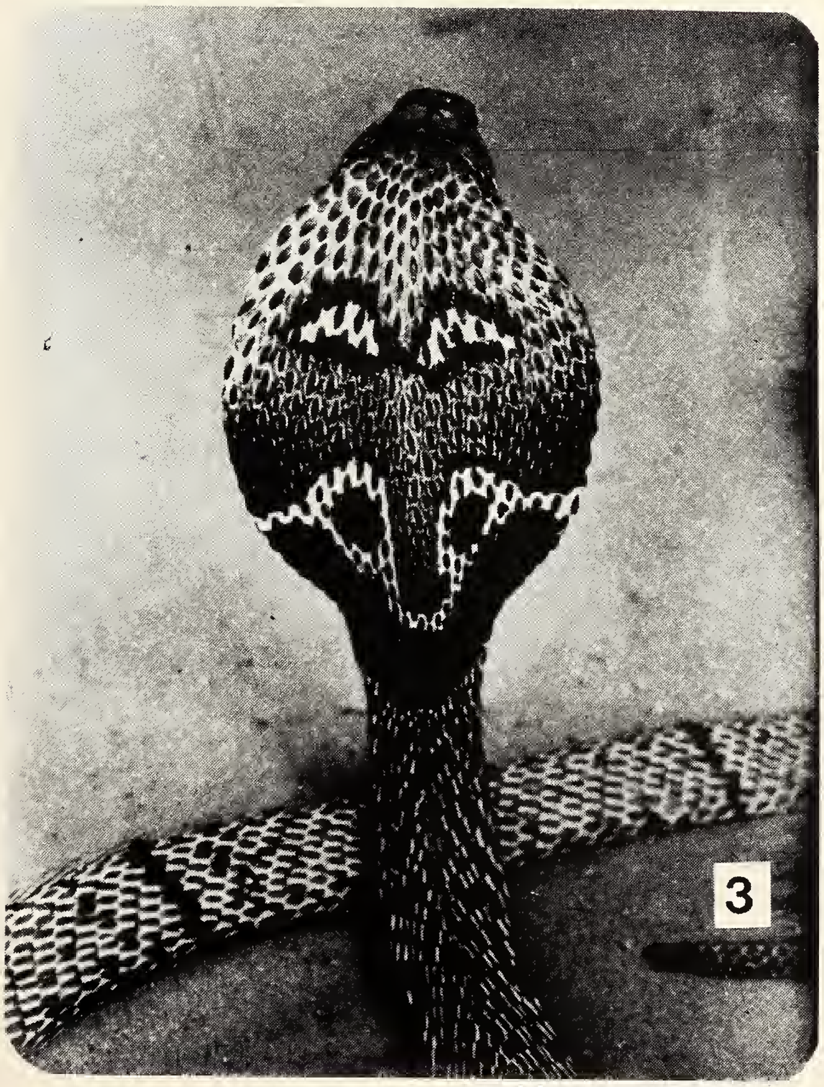
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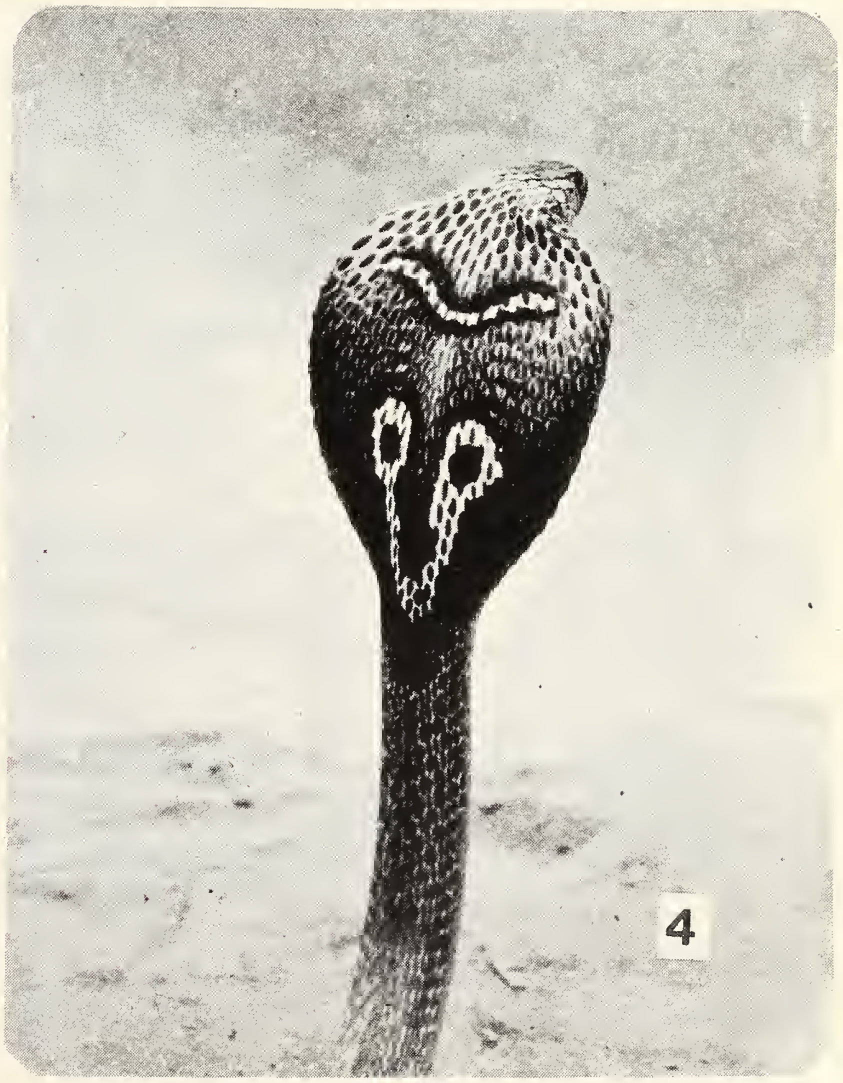
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Hood markings in Indian cobra.

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22. RECORD OF THE FROG *KALOULA PULCHRA* GRAY 1831 AT MAL-SAMOT, BHARUCH DIST., GUJARAT STATE

Mal-Samot is a village area situated on the left bank of Narmada river at a height of about 699 m above the sea-level. It is a part of Rajpipla Forest, East division. The river Devganga and many of its rivulets, flowing through the area, augment the vegetational cover there. From the westernside of Devganga river, we collected a frog which was resting on a tree-trunk at the height of about 2.4 m. The specimen was identified as *Kaloula pulchra* Gray, 1831. The fresh specimen had spots and patches of red with black-brown pattern on the dorsal side. Snout to vent length 35 mm. Inger & Dutta (1986) and Sekar (1991) reported its distributions from Assam, Karnataka, West Bengal, Tamil Nadu, Kerala and Madhya Pradesh.

December 16, 1992

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23. ICHTHYO-FAUNA OF SARISKA WILDLIFE SANCTUARY

Sariska tiger reserve (27°5′ to 27° 33′ N and 76°17′ to 76° 34′ E) is situated in the Aravali range and lies in the semi-arid part of Rajasthan (Rodgers and Panwar 1988). The total area of the reserve is 800 sq. km. The tract is mainly hilly undulating and having numerous narrow valleys. There is no large perennial water body in Sariska, but there are a number of ephemeral streams and pools. As the summer advances, except in a few natural springs, water dries up from all water points. Though the fish fauna of Rajasthan has been extensively studied, no attempt was made to study the fishes of Sariska. Even in an extensive study conducted by Zoological Survey of India, only the reservoirs and tanks around Alvar region were included (Datta and Majumdar 1970).

During the first week of March, 1990, fish sampling was carried out from three perennial water points in Sariska, namely Pandupol, Algual and Bandipul, using cast net and seine. A total of 14 species were identified, belonging to the orders Cypriniformes and Siluriformes. A striking pattern in the distribution of fishes was observed (Table 1).

Noemachilus botia, *Labio boggut*, *Puntius sarana*, *Garra gotyla* and *Rasbora daniconius* were recorded only from Pandupol and Algual. These sampling points are situated at elevated and remote areas of the reserve. *Garra gotyla* and *Noemachilus botia* are considered to be hillstream fishes.

Since Bandipul is connected with a reservoir at Umrain (outside the reserve) during the monsoon, commercially important species such as *Cirrhinus mrigala* and *Wallago attu* might have migrated into Bandipul stream. There are about 14 ephemeral springs in Sariska. The villagers and pilgrims use these springs and pools and therefore none of them remain undisturbed. The management authority of Sariska should take immediate efforts to control the

Table 1

FISH SPECIES RECORDED FROM SARISKA

Species	Pandupol	Algual	Bandipul
Order CYPRINIFORMES			
1. *Noemachilus botia* (Ham.)	+	+	
2. *Labio bogggut* (Syk.)	+	++	
3. *Puntius sarana* (Ham.)	++	++	
4. *Garra gotyla* (Ham.)	++	++	
5. *Rasbora daniconius* (Ham.)	+++	+++	
6. *Esomus danricus* (Ham.)		+	
7. *Puntius sophore* (Ham.)		+	+
8. *Salmostoma bacaila* (Ham.)		++	+++
9. *Puntius ticto* (Ham.)		+	+++ (fry)
10. *Labio bata* (Ham.)			+
11. *Labio dero* (Hec.) ?			+
12. *Labio pangusia* (Ham.) ?			+
13. *Cirrhinus mrigala* (Ham.)			++
Order SILURIFORMES			
14. *Wallago attu* (Sch.)			++

use of detergents by the villagers and pilgrims at all natural waterpoints, since it will affect the fish fauna and fish-eating birds such as Brown Fish Owl (*Bubo zeylonensis*).

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24. MATERNAL BEHAVIOUR IN A WEB SPINNER *PSEUDEMBIA FLAVA* ROSS (EMBIOPTERA : INSECTA)

In the insects, parental behaviour lies at the core of all levels of insect sociality and has arisen independently in atleast 13 different orders. Eickwort (1981). Maternal care has been recorded for many species of webspinners. After egg hatch, adult females were reported to stay with their nymphs in *Anisembia texana* (Mills 1932), *Oligotoma ceylonica ceylonica* (Bradoo 1967), *Embia major* (Imms 1913). The significance of these behaviour has not been studied, although it is known that female *Embia ramburi* provided macerated bark to newly hatched nymphs in laboratory colonies (Dennis 1949, Le Doux 1958). I have studied the maternal behaviour and its significance in *Pseudembia flava* with the following results.

To observe ovipositing behaviour, gravid females as evidenced by their distended abdomen were collected from the field. They were maintained in plastic containers 3.5 x 1.5 cm, stoppered with cap which has punched out entre-circle with cotton plug inserted was used. These were first filled with habitat material (bark) before introducing the live embiids. Hatching success was determined by examining emergence holes. Similarly to examine the impact of guarding on the survival rate of nymphs, separate containers composed of each nymphal group (I, II, and III stages) were

Table 1

PERCENTAGE OF SURVIVAL RATE OF NYMPHS WITH MATERNAL CARE AND WITHOUT MATERNAL CARE

Nymphal Stage	Nymphs along with mother			Nymphs separated from mother		
	Initial No. of nymphs	Number survived	Percentage survival	Initial no. of nymphs	Number survived	Percentage survival
I instar	20	10	50	20	5	25
	35	13	52	25	9	36
	30	17	56.6	30	12	40
II instar	20	15	75	20	10	50
	25	19	76	25	12	48
	30	23	76.6	30	19	63.3
III instar	20	18	90	20	15	75
	25	20	80	25	10	40
	30	26	86.6	30	20	66.6

maintained in the presence or absence of female embiids, providing a regular supply of habitat material and water.

The impact of maternal care on nymphs reared in the presence and absence of the female was made as shown in Table 1. There are marked differences in the survival rates of the two categories of nymphs. In the presence of the female, the first nymphal showed 50% survival; whereas in the absence there was only 25%. The first nymphal stage shows lesser percentage of survival than the second and third nymphal stages. The late nymphal stages, such as the third to fifth require less attention from the mother and are self supporting. The brooding female prepares the nest by chewing pieces of bark and having them in the nest. This not only serves the purpose of mechanical support and protection to the eggs, but also as food for the just emerged instars. The fourth and fifth nymphal stages are less dependent on the mother, and wander little distances making an independent attempt in search of food.

I thank the CSIR New Delhi for financial assistance, during the tenure of which this work was carried out.

July 21, 1992 C. RITA

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25. UNUSUAL FEEDING BY TERMITES

I stayed in tents during my short stay at Phanduwala, in Rajaji National Park, Dehradun in February 1992. As winter rains are very frequent in this region, I took my plastic synthetic raincoat along with me. I kept it in the side pocket of the tent in which I was staying but it fell down on ground due to negligence on my part. I did not notice it. On 13th Feb. 1992, when I was leaving the camp I found to my great surprise, that the plastic raincoat was partially eaten by termites and there were many holes in it. Termites usually feed on living and dead vegetation. Eating of plastic by termites is an astonishing fact.

This information can be used in the search of agents for converting non-biodegradable materials into degradable forms.

October 7, 1992 DHIRENDRA BHARGAVA
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26. SOME OBSERVATIONS ON LIFE CYCLE OF THE COMMON JEZEBEL *DELIAS EUCHARIS* DRURY

The life cycle of *Delias eucharis* Drury was studied in detail by Bell (1912). He observed that the insect lays eggs in batches of 10 to 20 on the underside of leaf of the tree parasite *Dendrophthoe*, and when the larvae hatch out, they first completely devour the egg shell from which they emerge, and having done so proceed to the margin of the leaf. Here they start feeding on the leaf, working side by side, and devouring it.

On 2nd August 1992 we saw three congregation each of 35-40 larvae on the twig of a *Dedrophthoe* parasitising *Cassia siamea*. We collected the infested branch. In doing so, the bulk of the larvae fell off to the ground, leaving 10 on the branch collected. The larvae were in the final instar, and pupated themselves the following day.

Bell had observed that when about to pupate each larvae goes off on its own and attaches itself by the tail pad and the girdle to a horizontal or perpendicular surface. However, out of the 10 larvae in our possession, 8 preferred to pupate on a single leaf resulting in pupal gregariousness, and the remaining two set about the process on two different leaves. The metamorphosed insect emerged a week later, contra to Bell, who found that a whole brood did not emerge at one time, the emergence we observed was at one single point of time in the evening.

Aplin *et al.* (1975) conclude Pieridae, supposedly to be a well protected group, generally aposematic in the adult stage and in some species through their life cycle. In the case of the Common Jezebel we are inclined to believe that larval and pupal gregariousness are the result of the aposematic nature owing to the chemical content ingested by them from their food plant *Dendrophthoe falcata* which in turn derived it from its host *Cassia siamea*. The leaves and pods of *Cassia siamea* hold a toxic alkaloid C_{14} H_{19} 0_3N which is fatal to pig. A powdery substance with a golden color darkening on exposure to air is present in the central hollow space. The chief constituent of the material is chrysophanhydroanthron C_{15} $H_{12}O_3$ (Wehmer 1931), which proves harmful to livestock feeding on the plant. This may have led to pupal gregariousness as on a dull background creamish yellow pupae with black markings are more conspicuous and warn a predator to keep off.

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27. HOW DO THE BUTTERFLIES RAISE THEIR TEMPERATURE ON COLD AND MISTY DAYS?

On a windy, rainy and misty day at Kodayar (1220 m) in the Western Ghats of Tamil Nadu, we made an interesting observation on the thermoregulation of Red Disc Bushbrown (*Mycalesis oculus* Marshall). On a open path with water flowing everywhere, they were two or three pairs of these butterflies trying to raise their temperature by orienting themselves to the intermittent sunlight, whenever it became a little clear. Butterflies are heliotherms known to raise the temperature by behavioural acts like basking with a wings stretched, maintaining ground contact with their abdomen or by shivering (Clench 1966).

However, one of them had novel way to boost its temperature. It sat on the running water, letting its abdomen touch the water. We measured the temperature of the water and the air. The temperature of the water was 1° C warmer than the air. While doing this, the butterfly kept the wings closed, so obviously it was raising its temperature from the flowing water.

September 29, 1992

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REFERENCE

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28. *CATOPSILIA POMONA* FABRICIUS (LEPIDOPTERA: PIERIDAE) AT HIGH ELEVATION IN THE U.P. HIMALAYA

Catopsilia pomona Fabricius is a well known migrant (Peile 1937, Wynter-Blyth 1957, Larsen 1987). In the hill districts of western Uttar Pradesh, this species regularly migrates down the Bhimtal valley (*c.* 1750 to 1400 m) in Nainital district, in the outermost ranges of the Himalaya, in a north to south direction, in August.

Wynter-Blyth (1957) observes that this species occurs up to 8000 feet (2438 m) in the hills. There does not appear to be any record of this butterfly from high elevation alpine meadows.

I found the carcass of a male *C. pomona* form *crocale* Cramer on July 26, 1987, lacking the right hand side hind wing, the tattered wings held together by the shell of the thorax, on the west face of a spur at approximately 4200 m elevation in the Khiron Valley in the Chamoli district of Garhwal (30° 1.5′ N, 79° 26′ E). The specimen appears not to have weathered a winter at that elevation.

On August 19, 1992, I observed a number, approximately 25 to 30 specimens of this butterfly flighting lower down the Khiron valley, which runs downwards from west to east. The butterfly came over a spur at approximately 3000 m elevation, down past Khiron village at 2600 m to the valley of the Alaknanda at approximately 2000 m elevation. Of these, I managed to obtain a male of the *crocale* Cramer form and a female of the *pomona* Fabricius form at approximately 2800 m elevation.

On August 20, 1992, I saw a male of the species briskly fly past further up the valley at 3600 m elevation, travelling in the same direction as the individuals the previous day. Fog restricted possible further sightings.

It therefore appears that the specimen I found further up the valley at 4200 m in 1987 was not accidentally blown there by an updraft but "fell by the wayside" on a migration.

The upper reaches of the Khiron valley are flanked by high ridges (4800 to 6500 m) on all sides except to the east. From the direction of flight, it would appear that these butterflies crossed into the upper reaches of the Khiron valley from a neighbouring valley. They must therefore have crossed the surrounding ridges at an elevation of well over 4200 m.

ACKNOWLEDGEMENT

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October 9, 1992 PETER SMETACEK
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29. OCCURRENCE OF *COPIDOGNATHUS SIDEUS* BARTSCH, 1982 (HALACARIDAE: ACARI) FROM INDIAN COAST

(With twelve text-figures)

INTRODUCTION

A faunistic survey for the marine halacarid mites along the Indian coast conducted by us resulted in bringing to light several species hitherto not known either along the Indian Coast or from the Indian seas. Preliminary findings of these survey have already been published by us (Chatterjee 1991 a, b; Sarma and Chatterjee 1991, 1993). *Copidognathus sideus* Bartsch, 1982 is reported for the first time along the Indian coast. The biosystematic significance of the present report lies in that the males, larvae and protonymphal stage of the species are described and figured for the first time besides that of the females. The species was previously known only from its type locality, based on a single female, collected from Mozambique channel in the Western Indian Ocean region (Bartsch 1982).

Locality: Many specimens were collected from the thalli of the halophyte *Potamogeton* sp. and rhodophycean *Gracilaria* sp. occurring in Chilka lagoon (Bay of Bengal). A few specimens were also recovered among *Enteromorpha* sp. in the brackish water biota of Cochin backwater, Kerala (Arabian Sea).

The specimens are in the author's collection in the Department of Life Science, Regional College of Education, Bhubaneswar.

Description: Male-Idiosomal lengths of males ranged between 340 μ and 370 μ .

All dorsal plates are separate and sculptured with both rosette pores and panells (Fig. 1). Anterodorsal plate (AD) with 3 areolae, one located anteriorly and two posteriorly. The posterior areolae may be rounded to pear-shaped with anterior end sometime elongated. A few rosette pores are embedded in the posterior margin of AD. The dorsal seta 1(ds_1) is located on the anterior margin of posterior areolae of AD and dorsal seta 2 (ds_2) on the anteromedian margin of Ocular plate (OC). The OC with two distinct cornea and two areolae. Of the two areolae, one is located in the corneal zone and the other halfway in the posterior region of the OC. Postero-dorsal plate (PD) bears four costae. The middle two costae are of two rosette pores width. The dorsal setae 3,4, and 5 respectively (ds_3, ds_4 and ds_5) are on the anterior, middle and posterior reaches of PD respectively and a pair of adanal setae are present on either side of anal palpalle.

All ventral plates are completely separate (Fig. 2). Anterior Epimeral plate (AE) and Posterior empimeral plate (PE) without any areolae. AE with three pairs of ventral setae and PE with 3 ventral and 1 dorsal seta. Very faint para-genital areolae are present. Genitoanal plate (GA) with 12-16 pairs of perigenital setae (PGS) besides 4 pairs of subgenital setae (SGS) located in the Genital opening (GO).

Rostrum is stout and strong with the rostral tip reaching the middle of the palpal patella (Fig. 4). A

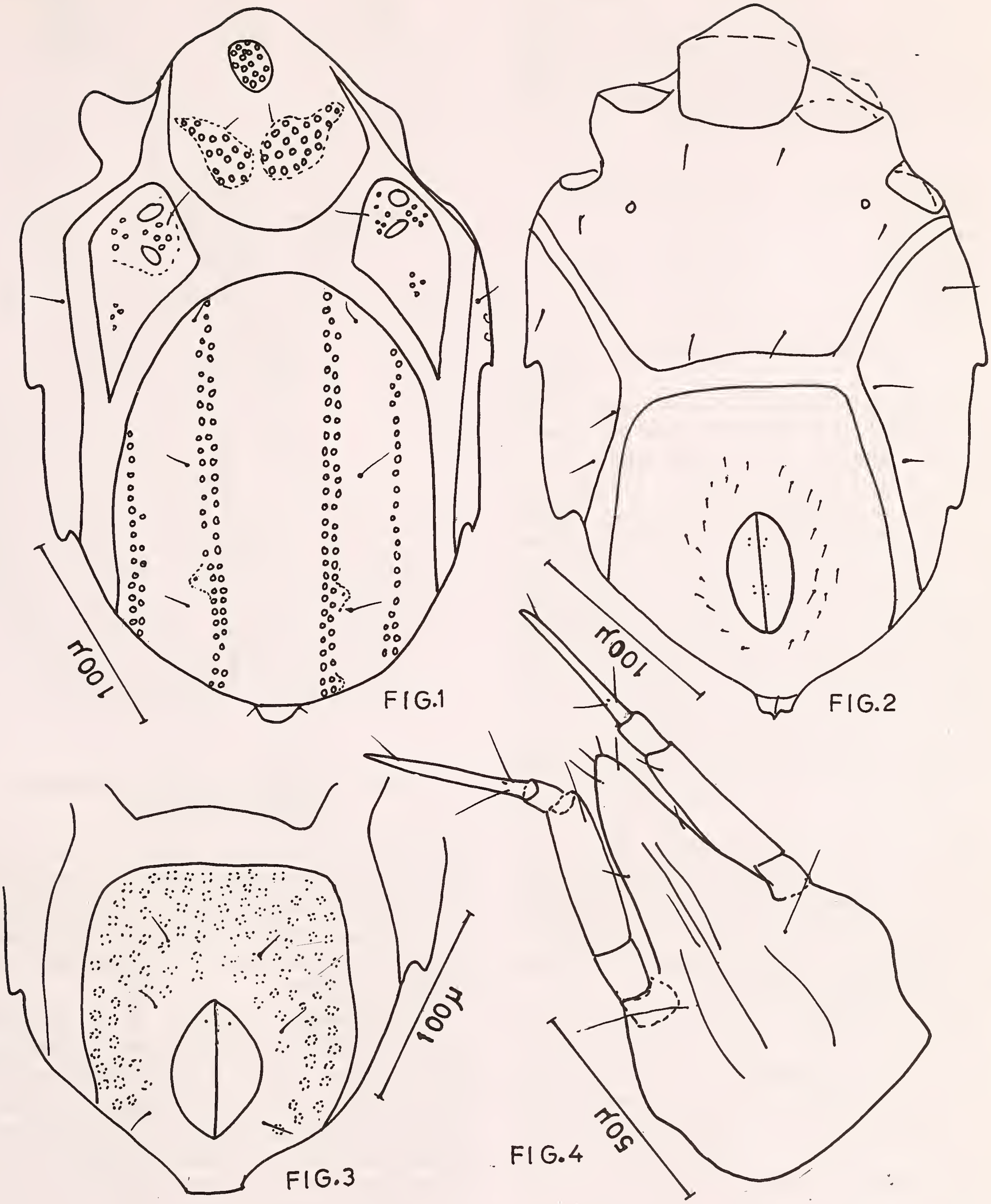
100µ
100µ
100µ
50µ

FIG.1 FIG.2 FIG.3 FIG.4

Fig. 1. Idiosoma-dorsal of male; Fig. 2. Idiosoma-ventral of male; Fig. 3. Genitoanal plate of female; Fig. 4. Gnathosoma of male.

pair of Proto-, deuto-trito-besirostral setae are present on gnathosoma. Gnathosoma ventro-laterally is panelled and ventro-medially beset with canaliculi. Palp is 4-segmented. Palpal trochanter and patella are without any seta. Palpal femur bears one dorsal setae. Palpal tibiotarsus with 3 basal setae and one distal eupathidia.

The chaetotaxy of	legs I-IV as follows:
Trochanter	1-1-1-0
Basifemur	2-2-2-2
Telofemur	5-5-2-2
Patella	4-4-3-4
Tibia	7-7-5-5

Tarsi setation is discussed in the text.

Telofemora III and IV devoid of any ventral setae. Tibiae I and II have three ventral setae and 4 dorsal setae. Tarsus I has 3 dorsal long setae, 1 solenidion, 1 profamulus besides 3 ventral setae (one filiform seta basally and two distal singlet eupathidia) and 4 parambulacral setae (two doublets eupathidia) (fig. 5). Tarsus II with 3 dorsal long setae, 1 solenidion, no ventral seta and 2 eupathidia doublets (parambulacral setae) (Fig. 6). Tarsi III and IV bears 3 dorsal fossary setae, one proximo-dorsal seta and 2 parambulacral setae (figs. 7 and 8). All legs bear two lateral claws and a bidentate median claw. Lateral claw of tarsus I bears an accessory tooth dorsally and is not pectinate ventrally, while those of legs II-IV are pectinate and bear an accessory tooth.

FEMALE: The idiosomal length of females ranged between 340 μ and 375 μ. Similar to male except for the genitoanal plate. Three PGS on each side of the genital opening are present on GA. GO is guarded by a pair of sclerites bearing a single pair of SGS near the anterior end (Fig. 3).

Larva: Idiosoma of a larva measured 200 μ long and 150 μ wide. Three pairs of legs are present. All legs are 5 segmented. AD, OC and PD are separate. AD bears 3 rudimentary areolae (Fig. 9). OC is very small; with a rudimentary cornea on anterior side. PD bears 2 costae comprising of rudimentary pores. The costae are one pore wide. The first pair of setae (ds_1) are located anterior to the posterior rudimentary areolae of AD. Each of the membranous cuticular zones present between AD and OC and between AD and PD bear a pair of setae. The cuticular membranous zone between the AE and the anal plate is very wide. The genital plate is yet to appear. AE bears two pairs of setae and PE one seta. The anal plate is without any genital acetabula (Fig. 10).

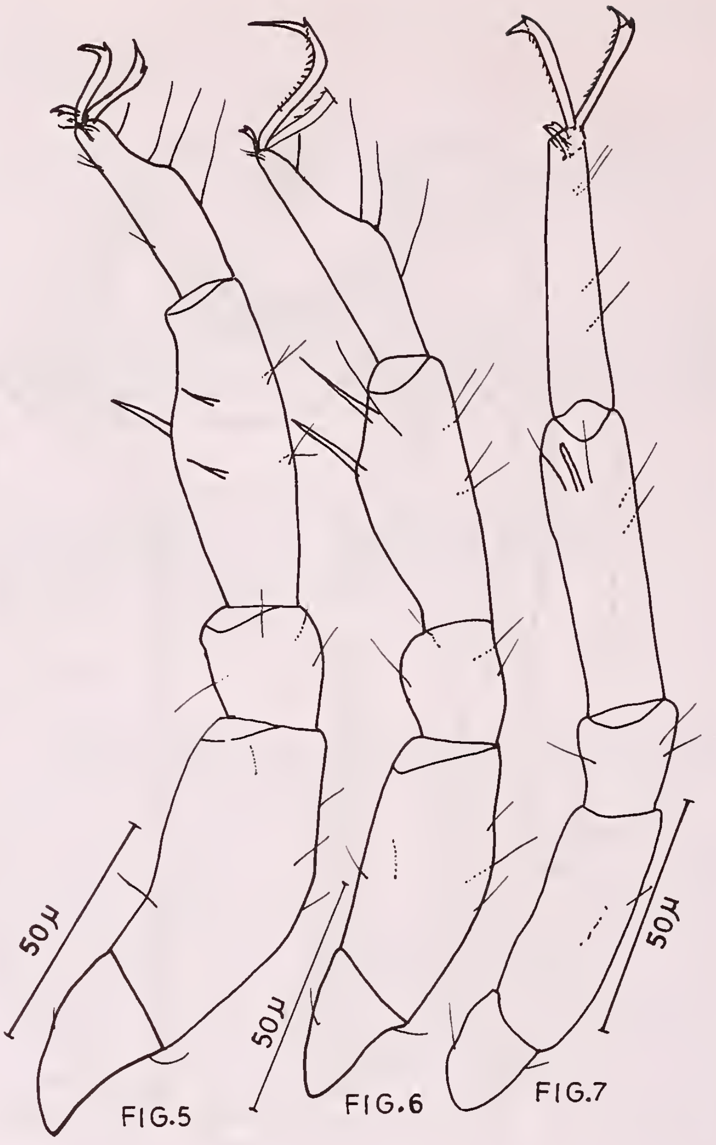

Fig. 5. Leg I of Male; Fig. 6. Leg II of Male; Fig. 7. Leg III of Male.

Protonymph: Idiosoma of a protonymph measured 267 μ long and 169 μ wide. Four pairs of legs are present. Legs I, II and III have 6-segments while the IVth leg bears only 5-segments. AD, OC and PD are separate (Fig. 11). All dorsal plates are smaller than those of adults. Areolae of AD are rudimentary and the rosette pores are not well developed. PD bears two costae. AE bears 3 pairs of setae. PE with two ventral setae. The setae on the dorsal plates conform with that of larva. Genital

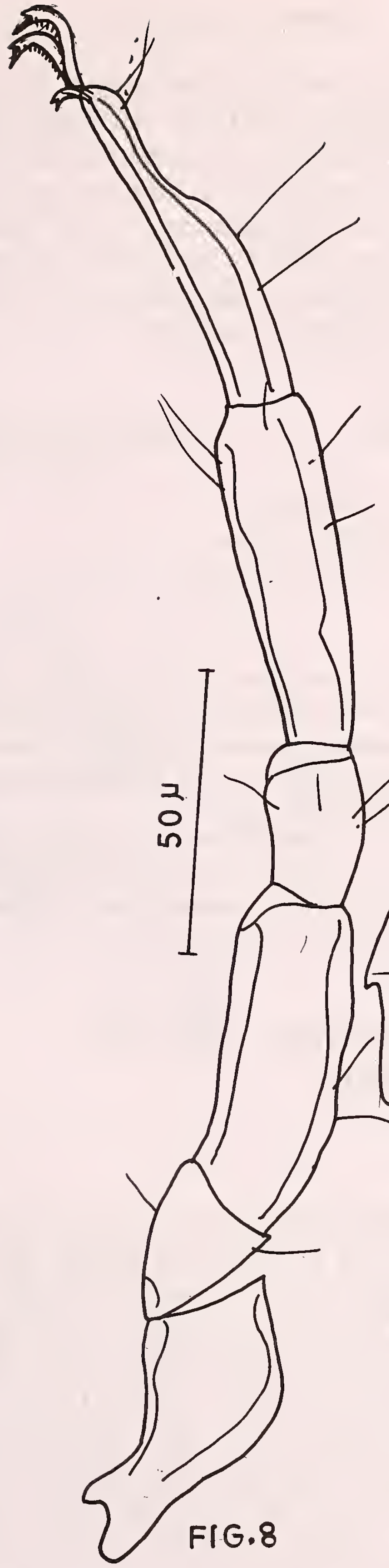

FIG.8

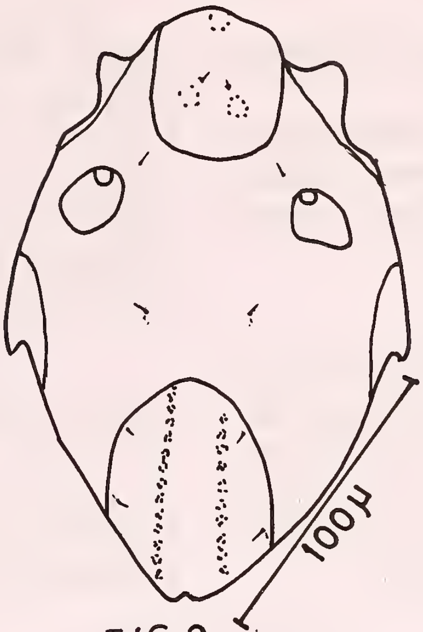

FIG.9

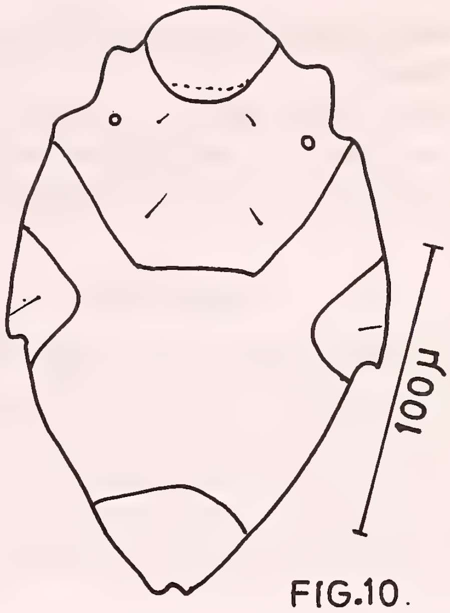

FIG.10.

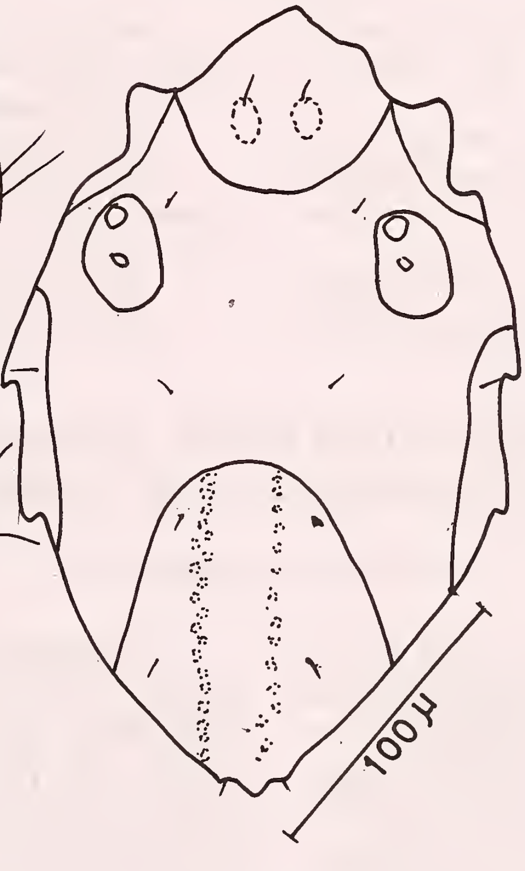

FIG.11

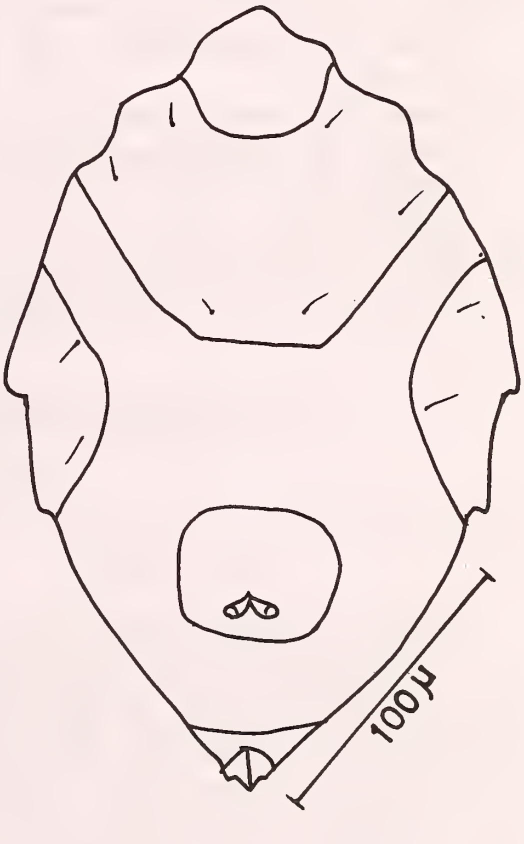

FIG.12

Fig. 8. Leg IV of male; Fig. 9. Idiosoma-dorsal of larva; Fig. 10. Idiosoma-ventral of larva; Fig. 11. Idiosoma-dorsal of protonymph; Fig. 12. Idiosoma-ventral of protonymph.

plates is completely separate from the anal plate. Genital plate with a single pair of genital acetabula (Fig. 12).

Distribution: Mozambique channel (Western Indian Ocean).

Chilka lagoon (Bay of Bengal), Eastern Indian Ocean —present record. Cochin backwater, Kerala Coast (Arabian Sea), Western Indian Ocean - present record.

DISCUSSION

This collection from the east and west coasts of India is the first record of this species from the Indian seas. The species appears to have a wide distribution in the Indian Ocean. The euryhalinity of the species is evident from its collection in brackish, lagoonal and marine aquatic environments.

ACKNOWLEDGEMENTS

Thanks are due to Dr Ilse Bartsch, Biologische Anstalt Helgoland, FRG for her ready help in providing the necessary literature; to Mr P. K. S. Pillai, for his enthusiastic help at the time of collection of samples from the Cochin backwater. Thanks are also due to authorities of Regional College of Education, Bhubaneswar for extending the necessary laboratory facilities.

March 19, 1991

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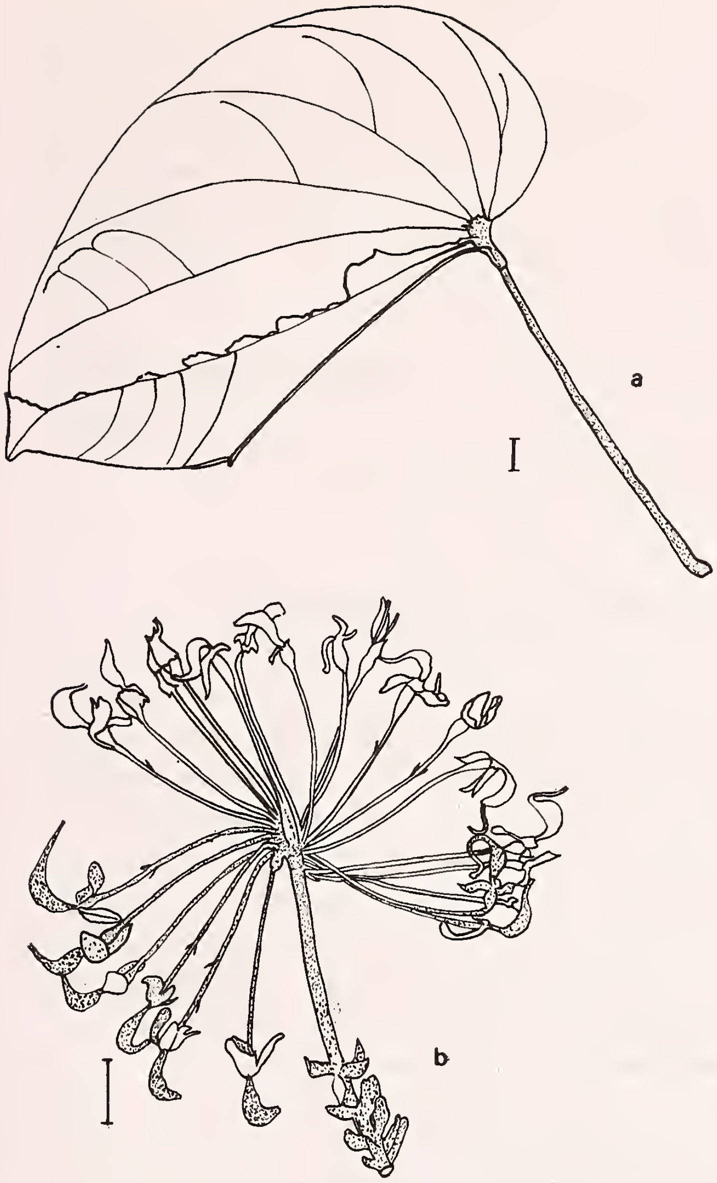
30. *BAUHINIA ORNATA* KURZ AND *B. TOURANENSIS* GAGNEP. (LEGUMINOSAE) NEW TO INDIA

(With two text-figures)

During a detailed taxonomic study on the Indian Bauhinias we came across some herbarium specimens which were wrongly identified. Two such specimens identified as '*Bauhinia rufa* Grah. and '*Bauhinia tenuiflora* Wall.' actually turned out to be *Bauhinia ornata* Kurz and *B. touranensis* Gagnep., hitherto unreported from the present day Indian circumscription and thus constituting new records for India.

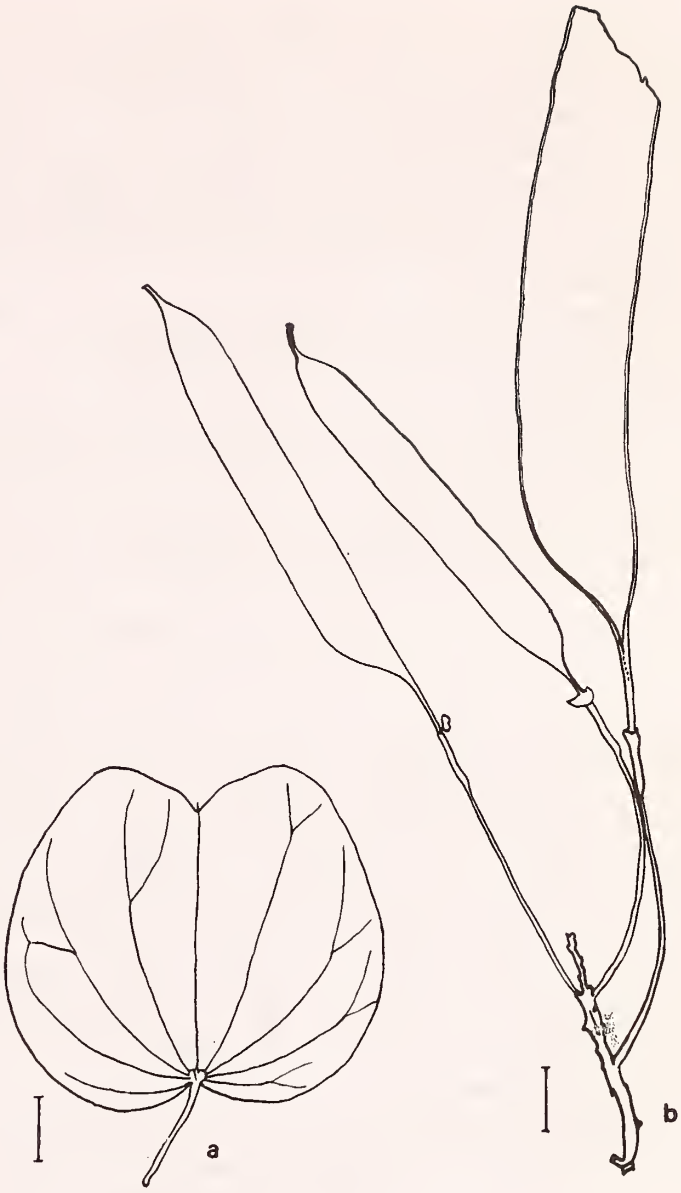
The morphological descriptions of the plant specimens together with their illustrations and other available data are provided.

1. **Bauhinia ornata** Kurz in J. Asiat. Soc. Bengal 42(2): 72. 1873 et J. Asiat. Soc. Bengal 45(2): 288. 1876; Baker in Hook. f., Fl. Brit. India 2: 281. 1878; Brandis, Ind. Trees 259. 1906; Soe in Union Burma J. Life Sci. 5: 312. 1972; Larsen & Larsen in Nat. Hist. Bull. Siam Soc. 25 (1 & 2): 13. 1973; Larsen *et al.* in Aubrévillae & Leroy (EDs.). Fl. Cambodge, Laos & Vietnam 18: 206. 1980; Larsen & Larsen in Thai For. Bull. 13: 41. 1980. *Phanera ornata* (Kurz) Thoth. in Bull. Bot. Soc. Bengal 19(2): 134. 1965; Schmitz in Bull. Soc. Roy. Bot. Belg. 110 (1 & 2): 14. 1977 ut *ornata* (Kurz) Schemitz. (Fig. 1).



1

Fig. 1. *Bauhinia ornata* Kurz: a. Leaf, b. inflorescence. (Scale = 1 cm).



2

Fig. 2. *B. touranensis* Gagnep.: a. Leaf, b. immature pods. (Scale = 1 cm).

Large tendrilled climber. Leaf 19.5 x 18 cm, broadly ovate. 13-nerved, bifid *c.* 1/3 their length into subacute lobes at apex, cordate at base, glabrous above, glabrescent below along nerves; Petiole 12.3 cm long, pubescent. Stipules *c.* 0.6 x 0.4 cm, oblong, obtuse at apex, densely pubescent. Inflorescence subumbelliform, 10 x 9 cm. Pedicels *c.* 3 cm long, pubescent. Bracts subulate; bracteoles minute, situated high up on pedicel. Receptacle *c.* 0.5 cm long, turbinate, pubescent. Calyx *c.* 0.6 cm long, 2-3-lobed, pubescent. Stipe *c.* 0.1 cm long; ovary *c.* 0.6 cm long, densely ferruginous pubescent; style *c.* 0.8 cm long, glabrous towards the minutely peltate stigma.

Type: Pegu, *Kurz* 2579 (CAL!).

Distribution: INDIA: Nagaland; Burma.

SPECIMEN EXAMINED: Naga hills, Nagaland, *F. Kingdon Ward* 11245 (CAL).

This specimen, however, differs from the type material in having densely pubescent inflorescence, comparatively stout pedicels and glabrous stigma.

2. **Bauhinia touranensis** Gagnep. in Lec., Not. Syst. 2: 181. 1912; Chen in Ling. Sci. J. 18(4): 475. 1939; Larsen *et al.* in Aubréville & Leroy (Eds.), Fl. Cambodge, Laos & Vietnam 18: 186. 1980. *Phanera touranensis* (Gagnep.) Schmitz in Bull. Jard. Bot. Nat. Belg. 43: 381. 1973. (Fig. 2).

Tendrilled climber; branch glabrous. Leaves 5.5–6 x 6.2–6.5 cm, ovate to suborbicular, 9 nerved, bifid 1/7 their length into obtuse lobes at apex, shallowly cordate at base, glabrous above, pubescent below; petioles 1.9–2.4 cm long, glabrous. Pods up to 10 x 1.9 cm (immature), oblong, glabrous; stalk *c.* 4.5 cm long, glabrescent.

Type: Tourane, Cochinchine, Janvier 1837, *Gaudichaud* 260 (Syntype: P, photo. – CAL!).

Fr.: June.

DISTRIBUTION: INDIA: Arunachal Pradesh; Burma, Laos, Vietnam and China.

SPECIMEN EXAMINED: Noglo, Tirap F.D., Arunachal Pradesh, 29-6-1961, *D.B. Deb* 26322 (CAL).

ACKNOWLEDGEMENTS

We are grateful to Prof. Kai Larsen of Aarhus University, Denmark for his comments on the identity of the plant specimens and to the authorities of the Museum National d'Histoire Naturelle, Laboratoire de Phanerogamie, Paris for providing the negative of the type specimen.

January 15, 1993

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31. ADDITIONS TO THE MYRSINACEOUS FLORA OF BURMA

During taxonomic study of the family Myrsinaceae in India, we came across some unidentified specimens collected from Burma, deposited in Central National Herbarium (CAL). Critical study of these specimens reveal that these belong to three species so far unrecorded from Burma. Full descriptions of these three species namely *Embelia pulchella* Mez; *Labisia pumila* (Blume) Benth. et Hook. f. and *Maesa argentea* Wall. are given below:

Embelia pulchella Mez, in Engl. Pflanzenr. 4: 324. 1902; Kanjilal *et al.*, Fl. Assam 3: 170. 1939.

Woody shrubs, branches slender, densely ferrugineous pilose. Leaves exstipulate, alternate, ovate-oblong, 8-25 x 6-10 mm, base rounded, sub-rounded or truncate, margin entire, recurved, ciliate, midrib prominent beneath, other nerves inconspicuous, glabrous except on the midrib particularly beneath which sparsely to densely covered with rusty-puberulous hairs, upper surfaces turn blackish and lower surfaces turn deep brown on drying; petioles hardly 1 mm long, rusty-puberulous. Inflorescence axillary subumbellate, peduncle as long as petiole, 10 flowered, densely rusty puberulous. Flower unisexual, sessile or subsessile. Sepals 5, united at base, ovate-acute, puberulous dorsally, margin ciliated. Petals 5, free, elliptic, 2 x 1 mm, dorsally sparsely puberulous, ventrally and at margin densely rusty puberulous, not gland-dotted. Stamens 5, epipetalous, filaments for male flower larger than anthers, filaments in female flowers as long as anthers. Ovary in male flower small, abortive, ovary in female flowers globose, distinct, densely covered with rusty puberulous hairs, styles in female flower curved or coiled, glabrous. Fruit not seen.

This species is closely allied to *E. parviflora* Wall. but can be easily distinguished by its leaves rounded at apex, sparsely pilose along nerves, petals sparsely puberulous dorsally and ovary densely pilose.

Distribution: INDIA; Burma.

Mez (1902) described this species from North-eastern India based on the collections from Assam (Griffith 3545) and Manipur (Watt 7277). There is no further record of the plant from adjacent areas. The new record presented here from Burma is also based on the old collection (1909). So, further search is necessary to establish its present status.

Specimen cited for the new distribution: Kung Tung, S. Shun State, ± 4000 ft. (1216 m), Dec. 1909, *Capt. R. W. MacGregor* 1137 (CAL).

Labisia pumila (Blume) Benth. et Hook. f. var. pumila. Benth. et Hook. f. Gen. Pl. 2 : 645. 1876; Mez in Engl. Pflanzenr. 4: 171. 1902. *Ardisia pumila* Blume, Bijdr. 688. 1826; A. DC., Prodr. 8: 1844; Fl. Ind. Bot. 2: 1028. 1856. *Ardisia spicata* Wall. Num. List. no. 2773. 1830; A. DC. in Trans. Linn. Soc. 17: 135. 1834. *Labisia pothoina* Lindl. in Bot. Reg. 31 et t. 48. 1845; C.B. Clarke in Hook. f. Fl. Brit. India 3 : 518. 1882.

Erect or decumbent herbs, often with creeping rhizomes, younger parts sparsely ferrugineous.

Leaves exstipulate, alternate, lanceolate, elliptic-lanceolate or oblanceolate (4-) 12-18 (-25) cm long including the petiole, (1.6-) 3.5 – 4.5 (6.0) cm broad, base of the lamina attenuately extended throughout the whole length of the petiole as a wing, apex acute, margin entire or decurrent, midrib raised beneath, primary nerves numerous, more or less right angled to the midrib and run parallel, upper surface of lamina glabrous, lower surface glabrous or rusty-pubescent near the midrib, sparsely gland dotted, chartaceous, turn dull green on drying. Inflorescence axillary peduncle, peduncle 2-6 cm long, ferrugineously tomentose. Calyx 5-toothed, sepal triangular 0.5 mm long, dorsally ferrugineously tomentose; petals 5, ovate, sparsely ferrugineous tomentose dorsally, induplicate - valvate in bud. Stamens 5, epipetalous, filaments very short, anthers oblong, acute, connective slightly prolonged. Ovary globose, ferrugineously tomentose, style cylindric, stigma capitate. Fruit globose, one-seeded, ovules uniseriate.

Distribution: Java, Sumatra, Borneo, Malaya Peninsula, Burma. So far, the report of this species from Burma establishes its extended distribution towards north.

Specimens cited for the new distribution: Upper cinchoua camp, Burma, 28-3-1924, *C.C. Calder* s.n. (CAL); on the way to the base camp Kycinchemg forest, Tenasserim, Burma, 100 feet (30 m), 18-2-1931, *K. Biswas* 1160 (CAL); Miachung, near Lepokechemg, Tenasserim, Burma, 300-400 feet (90-120 m), 13-2-1931, *K. Biswas* 920 (CAL).

Maesa argentea Wall. in Roxb. Fl. Ind. ed. Carey 2 : 333. 1824; A. DC. in Ann. Sc. Nat. 2. Ser. 16. t. 5. 1841. et in DC., Prodr. 8 : 81. 1844; Brandis, For. Fl. 283. 1874; Clarke in Hook f., Fl. Brit. India 3: 510. 1882; Mez in Pflanzenr. 4: 39. 1902. *Beobotrys argentea* Wall. Num. List. no. 2316. 1829.

Shrubs, stem and branches round, densely brownish pilose particularly the younger parts. Leaves exstipulate; alternate, elliptic, (8-) 10-12 (-17) x 4.5-6.0 (-7.0) cm, base acute to cuneate, apex acuminate, margin dentate serrate, primary nerves prominent, 8-12 on each side of midrib, upper surfaces of lamina sparsely puberulous, lower surfaces usually densely puberulous particularly on the nerves, sparsely gland dotted, membranous; petioles 8-25 mm long, densely puberulous, flowers compact, bracts triangular, 0.5 mm long, puberulous dorsally, bracteoles 2, like those of bracts; pedicels 1-2 mm long, puberulous. Calyx 5-toothed, lobes broadly triangular, 0.5 x 0.5 mm, margin ciliate, punctate or not. Corolla 2-2.5 mm long, white, 3/4 connate, lobes 5, ovate rounded, margin minutely crenulate, not punctate. Stamens 5, epipetalous, filaments 0.5 mm long, anthers ovate-rounded, dorsifixed. Ovary 3/4 inferior, style 0.5-1.0 mm long, stigma capitate. Fruits globose, 5 mm diam., one-seeded.

Distribution: INDIA; Nepal, Burma.

The species was previously recorded from Western to Central Himalaya extending from Kumaon to Nepal. The present new distribution in Burma establishes its further extension eastward. This disjunct distribution of the taxon requires thorough search for its possible records in the intermediate areas.

Specimens cited for the new distribution: Kyanksiu, N. Burma, 5000-6000 feet (1520-1824 m), 24-6-1914, *A. Rodger* 169 (CAL); Mount Victoria, Chun Hills, 9000, feet (2736 m), April 1939, *F.G. Dickason* 8497 (CAL).

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We thank Dr H.J. Chowdhery, Scientist 'SD', Arunachal Field Station, Botanical Survey of India, Itanagar, for all facilities and encouragement.

June 12, 1992

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32. SEISMONASTIC MOVEMENT OF STAMENS OF *OPUNTIA DILLENII*

Seismonasty is the movement brought by mechanical stimuli such as contact with a foreign body, poking with any hard object, drops of rains, a gust of wind, etc. Such a movement is known in many plants like *Mimosa pudica*, *Biophytum sensitivum*, *Neptunia*, *Averrhoa*, *Dionaea* etc.

Stamens of *Opuntia dillenii* are other interesting examples of seismonastic movement. In opened flowers of this species, the stamens are fully spread above the petals. Whenever they are touched with a finger or stick, they start rising above the petals and start converging inwards and soon attain an erect position in the central portion of the flower around stigma. Whenever some nectar probing insect comes in contact of stamens, the latter show inward movement and due to their convergence more and more stamens come in contact with the insect, spilling pollen mass on body of insect. Thus, the seismonastic movement of stamens of *Opuntia dillenii* enhance and facilitate its cross pollination through insects.

January 6, 1993 SATISH KUMAR SHARMA

Aravalli Afforestation Programme, Jhadol (F.),
Udaipur Dist., Rajasthan.

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33. FLOWER-VISITORS AND POLLINATION OF *ADHATODA ZEYLANICA* NEES (ACANTHACEAE)

Plant-animal interactions, particularly at the flower level, are related to the structure, organisation and continued functioning of the respective communities (Heithaus 1974, Frankie 1976, Moldenke 1975, 1979). There is need to understand such interactions, especially in the species rich tropical ecosystem(s). The interaction of 13 insect species with the flowers of *Adhatoda zeylanica* Nees (Acanthaceae), a large tropical shrub and an important medicinal plant is described here.

Adhatoda zeylanica blooms at Visakhapatnam (17°42′N and 82° 18′ E), every year, from January to early April. Flowers are borne in the exils of leafy bracts on 5-9 cm long pedunculate spike inflorescence. They are zygomorphic, the corolla base forming a short tube and the upper part becoming 2-lipped and galeate. The outer three petals are imbricate; the opposite two are united, their facial margins forming a narrow groove through which passes the filiform style with its linear stigma. The two epipetalous stamens with the introrse anthers are inserted in the corolla over most part of their length and are placed, together with the style, adjacent to and covered by the upper hooded corolla lobe. The style is projected slightly beyond the stigma, thereby precluding contact with anthers when they dehisce.

The flowers anthese during the period from 0730 to 1830 h, a maximum anthesing being before 1100 h. Anthers dehisce shortly after anthesis, exposing the pollens visible to the naked eye as white powdery mass. Pollen grains are large in size (65 x 45 mm), their number per anther averages 17800. Along with the anthesis nectar secretion also begins. But the secretion is in traces and it continues up to the time the flower drops off after 48 hours of anthesis. Hand-refractometer readings showed that the sugar concentrations range from 17 to 22%. Paper chromatographic analysis revealed the presence of sugars namely Sucrose, Glucose and Fructose, the Sucrose being the dominant constituent. Amino acids and proteins are also present as indicated by Ninhydrine and Bromo-phenol tests respectively.

In the flowering season of 1986, in all 13 insect species, 10 belonging to Hymenoptera and 3 to Lepidoptera, were found foraging on the flowers of *A. zeylanica* (Table 1). The visits of *Amegilla* sp., *Trigons* sp., *Ceratina* sp., *Pithitis* sp., and *Pseudapis* sp. among the Hymenoptera were directed to pollen collection only. The other Hymenoptera and the Lepidoptera confined their visits to nectar foraging. The 13 species could only be recorded in the peak flowering phase only, while in the other phases some of them were found to be absent. In all the three flowering phases, *Amegilla* and *Apis cerana indica* made a larger number of visits than other species. At the peak phase of flowering, besides these two species, *Xylocopa* and *Macroglossum* also shared a sizable proportion of the total visits. The absence of *Xylocopa* in the initial phase could be understood because in that period it mostly concentrated on *Glyricidia maculata* on mass bloom.

All the 13 flower-visitors are diurnal in their activity. They visited the flowers during 0630 to 1900 h. The first insect to visit the flowers was *Macroglossum gyrans*. It foraged at the flowers for

TABLE 1
FLOWER-VISITORS OF *A. Zeylanica*, THEIR FORAGE TYPE, AND THEIR VISITATION RATES RATES IN DIFFERENT PHASES OF FLOWERING IN 1986.

Insect Species	Forage Type		Flowering Phase					
	Nectar	Pollen	Initial 27.1.1986	(%)	Peak 17.2.1986	(%)	Final 22.3.1986	(%)
HYMENOPTERA								
BEES								
Apis cerana indica	+	+	445	(33)	654	(20)	443	(28)
Trigona sp.	–	+	65	(5)	78	(2)	74	(5)
Xylocopa pubescens	+	–	0		361	(11)	41	(3)
Xylocopa latipes	+	–	0	0	409	(13)	102	(6)
Pseudapis oxybeloides	–	+	138	(10)	182	(6)	156	(10)
Ceratina sp.	–	+	92	(7)	106	(3)	115	(7)
Amegilla sp	+	+	600	(45)	788	(25)	564	(32)
Pithitis binghami	–	+	0		47	(1.5)	0	
WASPS								
Delta conedus	+	–	0		12	(0.5)	0	
Scolia sp.	+	–	0		31	(11)	0	
LEPIDOPTERA MOTHS								
Macroglassum gyrans	+	–	0		348	(11)	0	
BUTTERFLIES								
Euploea core	+	–	0		72	(2)	27	(2)
Pelopidas mathias	+	–	0		122	(4)	45	(3)
Total visits			1340		3210		1567	

2 hours in the morning and also for 2 hours in the evening when other visitors were less active. Probably, the stratified foraging behaviour is a strategy to avoid competition with other foragers. *Amegilla* and *Apis* were active all through from 0630 to 1900 h. The activity of *Pseudapis* started late in the morning and ceased early in the evening, so also that of *Ceratina* and some butterflies. Both the species of *Xylocopa* began their activity slightly late in the morning and finished it a little early in the evening. The activity of the various foragers was not correlated to the weather parameters. It is assumed that the availability of forage might determine the visitation rates. Accordingly, in the period before 1100 h there was a tendency for greater activity because more number of flowers open at that time. Although *Macroglossum gyrans* appeared to confine itself to a cooler part of the day, observations of its activity on other plant species in the same biotope did not provide any support for such a behavioural pattern. Data regarding the number of flowers visited in a minute and the time spent on a flower by 8 of the more common visitors indicated that *M. gyrans* is a more mobile visitor covering on an average 57 flowers in a minute and spending an average time of 2 seconds per flower. The corresponding figures for other visitors are *Trigona* 13.5, 4.5; *Pseudapis* 12, 4; *A.c. indica* 7.5, 8.5; *Ceratina* 11, 5.5; *Amegilla* 8, 8.5; *Xylocopa latipes* 6, 12; and *X. pubescens* 5, 11.5.

Controlled pollination experiments revealed the total absence of apomixis. When tested for autogamy, 50% of the flower set fruit with seed set 100% and fecundity 50%. Those tested for geitonogamy yielded 75% fruit set, 100% seed set and 75% fecundity. Those for Xenogamy gave 90% fruit set, 100% seed set and 90% fecundity. A close examination of the intrafloral behaviour of the 13 visitors revealed that the carpenter bees *Xylocopa latipes* and *X. pubescens* only made meaningful contact with the essential flower parts while foraging, and vectored the pollen. The stamens and style being placed adjacent to the upper lobe, brushed against the upper side of the visitor thereby depositing or receiving pollen nototribically. When the carpenter bee probes the flower for nectar, its body size exactly fitted the gap between the two corolla lobes. The zygomorphic nature of the flowers with the essential parts placed towards the upper lip is a precise adaptation for Nototribic pollination by such large-bodied insects as *Xylocopas* (see Proctor and Yeo 1972). The role of this bee in vectoring pollen was verified by observing the stigmas for pollen after the flowers were visited by different visitors. Those stigmas visited by *Xylocopa* alone revealed pollen, thereby confirming the role of *Xylocopa* in pollination.

The pollinations that result from *Xylocopa* visitation of *A. zeylanica* flowers might be either auto-, Geitono- or Xeno-gamous. However, it was found that both the species of *Xylocopa* visited a few flowers in a foray and then flew away. This type of behaviour of the forager, together with the behaviour of the plant producing fewer number of flowers per day and with minimal quantities of nectar promote Xenogamy which is a superior mode of reproduction in *A. zeylanica* (Cruden 1976, Faegri & Pijl 1979).

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34. *REMIREA MARITIMA* AUBL. (CYPERACEAE) — A NEW RECORD TO THE SEDGE FLORA OF ANDHRA PRADESH

(With a text-figure)

During the study of the sedge flora of Andhra Pradesh a Cyperaceous species was collected from Thungabhadra river bed near Kurnool town. On critical study and comparison with specimens housed at CAL it was identified as *Remirea maritima* Aubl. This species was recorded earlier from Kerala and Karnataka and the present report extends its distribution to the Andhra Pradesh. Since this is the first report of this taxon from Andhra Pradesh a brief description and citation is given for its future collection and easy identification.

Remirea maritima Aubl. in Hist Pl. Guin. Franc. 1: 45. t. 16. 1775; FBI 6: 677. *R. pedunculata* R. Br. Prodr. Fl. Nov. Holl. 236. 1810. *R. maritima* Aubl. var. *pedunculata* Benth. Fl. Austr. 7: 347. 1878. *Mariscus pedunculatus* (R. Br.) T. Koyama in Gard. Bull. Singapore 30: 159. 1977 & in Dassan. & Fosb. Handb. Fl. Ceylon 5: 240. 1985. *Cyperus pedunculatus* (R. Br.) Kern. in Acta Bot. Neerl. 7: 798. 1958 & in Steenis, Fl. Males. 7: 644. 1974. *Mariscus maritimus* Miq. 1860, not of Clarke 1896.

Perennial rhizomatous herb, to 10 cm tall; rhizome horizontally long, creeping, branched, rooting at nodes, clothed with membranous, acute, brownish sheaths; culms tufted from the branched head of the rhizome, rigid trigonous. Leaves crowded, rigid, canaliculate, scabrid on the margins in upper part, very gradually narrowed to the

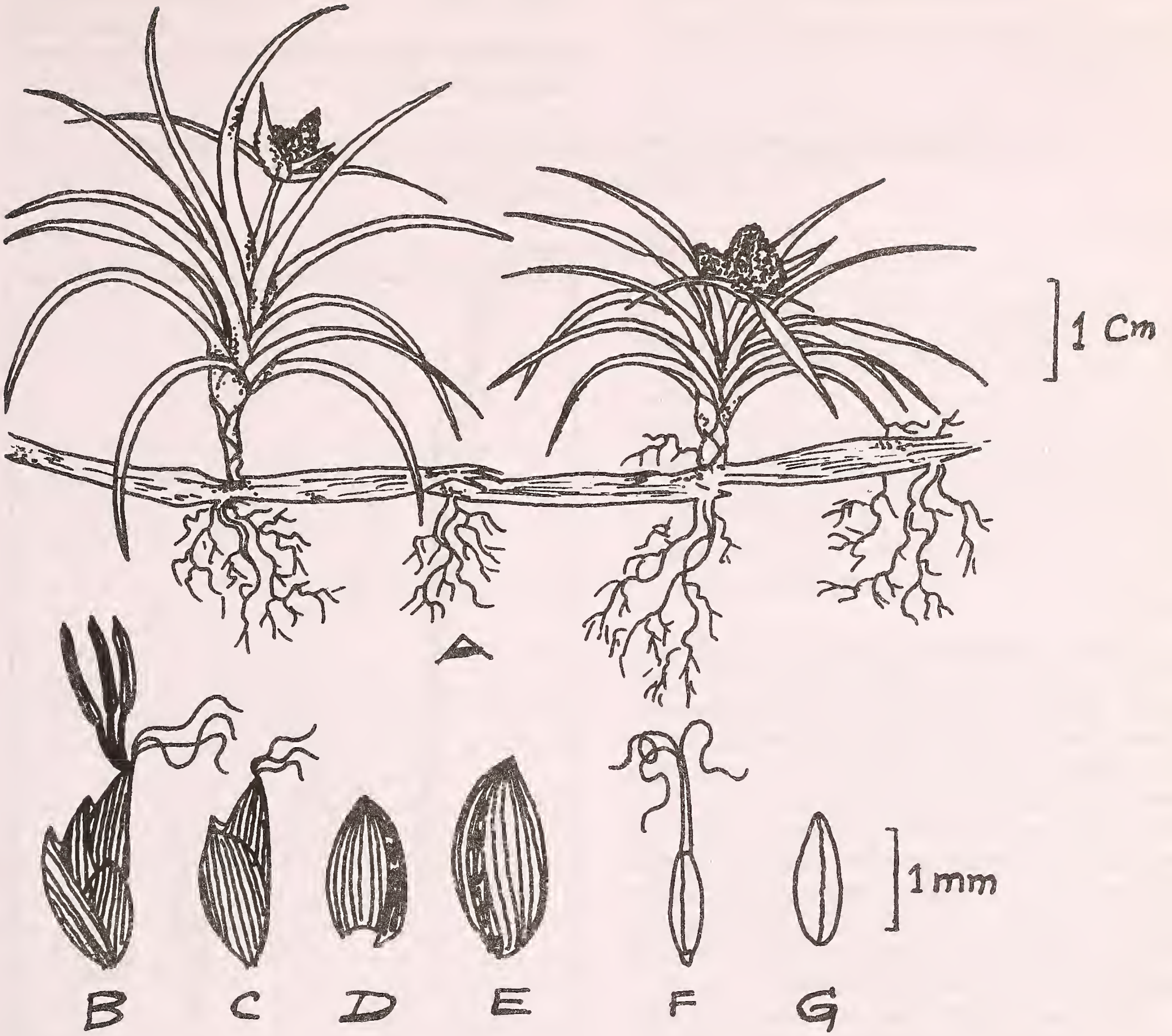

Fig. 1. *Remirea maritima* Aubl.
A. Habit; B. Flowering spikelet; C. Achene enclosed by upper glume; D. & E. Glumes;
F. Ovary with style and stigmas; G. Achene.

triquetrous, pungent tip. Inflorescence head-like, consisting of digitately arranged, sessile, short spikes. Involucral bracts 3-5, patent, the longest overtopping the inflorescence. Spike ovoid, to 12 mm long. Spikelets sessile, densely crowded, ovoid, acute, slightly compressed, 1-flowered, falling off as a whole; rhachilla disarticulating above the basal 2 glumes; uppermost internode strongly flattened, finally thickened, corky, to 3 mm long. Glumes broadly ovate, many- nerved, 3 lower ones empty, to 3 mm long, the uppermost vetigial. Stamens 3; anthers yellow. Stigmas 3. Achenes trigonous, oblong, slightly compressed, shining, tightly enclosed in the upper node of the rhachilla (Fig. 1).

Along wet, sandy edges of rivers and ponds in Kurnool district. **Fl. & Fr.:** August - December.

Specimens examined: Kurnool town, Thungabhadra river, 3-3- 91, *K. Hanumanthappa* 10953.

We thank the Joint Director, Central National Herbarium, Howrah for providing Herbarium and Library facilities.

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35. ON THE OCCURRENCE OF *PANICUM ELEGANTISSIMUM* HOOK. F. (POACEAE) IN INDIA

(With a text-figure)

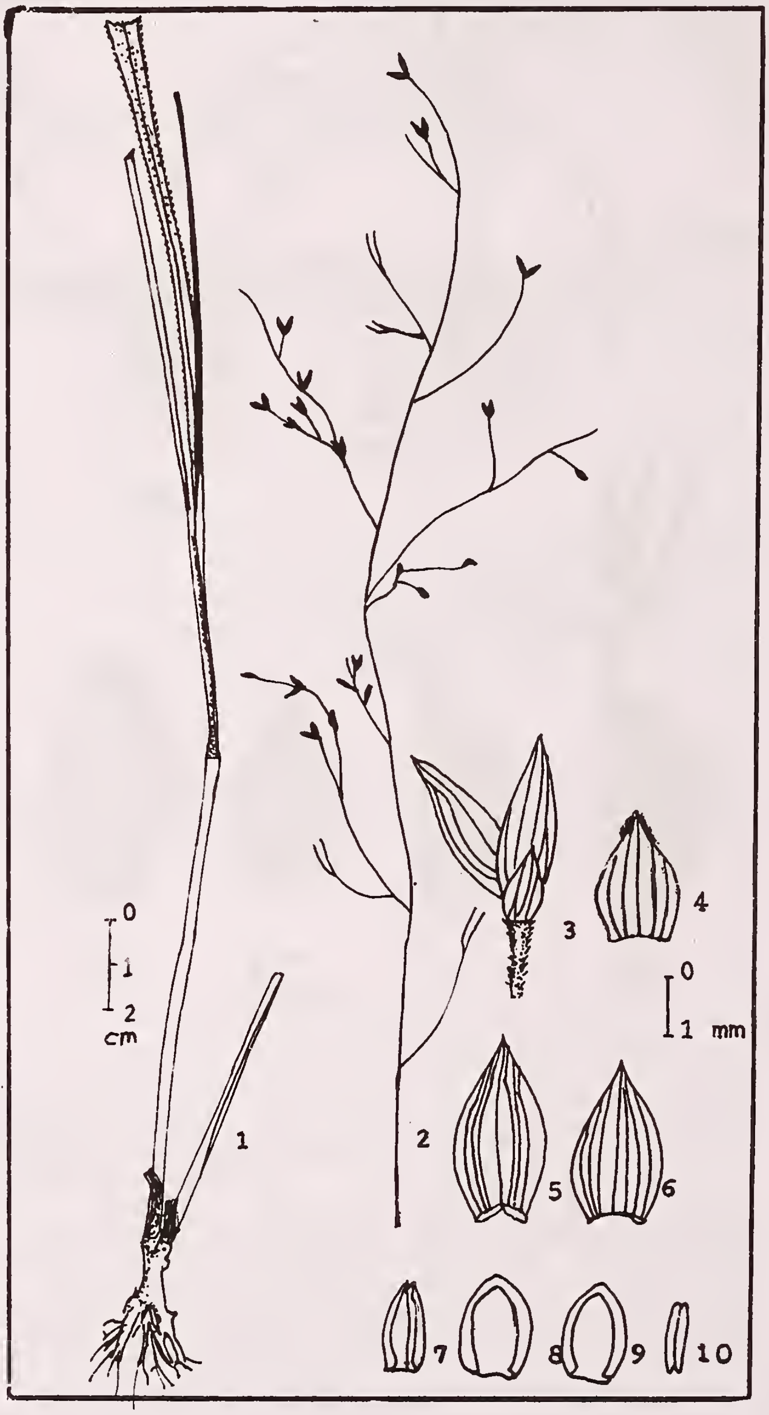

Fig. 1. *Panicum elegantissimum* Hook. f.
1. Habit; 2. Inflorescence; 3. Spikelet; 4. Lower glume; 5. Upper glume; 6. Lower lemma; 7. Palea; 8. & 9. Upper lemma and its palea; 10. Stamen.

D.K. Banerjee (1971) reported *Panicum elegantissimum* Hook.f. as a new record for India. Later, Majumdar (1973) also included it in his account of *Panicum* on the basis of Banerjee's collection. After critical analysis of two specimens (Banerjee 4860, 4860 A) at Central National Herbarium, Uniyal and Banerjee (1985) reported that these specimens are of *Panicum trypheron* Schult., not *P. elegantissimum* Hook. f., hence the occurrence of *P. elegantissimum* in India is doubtful.

During collection of grasses of Bihar, we collected a specimen which after critical study exactly matches the type of *P. elegantissimum*, (Lumut, State of Perak, Malay Peninsula, Ridley 3116, 1892) which is available in the Central National Herbarium. Eventhough, our plant looks like *P. trypheron*, it differs from the latter by its perennial habit, longer spikelets and lower glumes which are half or less the length of spikelets. The voucher specimens are housed in the Bhagalpur University Herbarium, Bhagalpur. The following description is based on live specimens.

Panicum elegantissimum Hook. f. Fl. Brit. Ind. 7: 52. 1896; Bor, Gr. Burma, Ceylon, India & Pak. 325. 1960.

A tufted perennial, up to 80 cm high. Culms erect, branched, slender, glabrous. Leaf-blades 5-35 x 0.4-0.6 cm, linear to linear-lanceolate, softly hairy on both surfaces, base narrow, apex acuminate; sheaths compressed, hispid; ligules fimbricate. Panicles up to 25 cm long, erect, effuse, lax, oblong-lanceolate; branches long, alternate, scabrid; pedicels with swollen tips, scabrid. Spikelets 3.5-4 mm long, in pair, ellipsoid, scattered, tip purple to green, acuminate. Lower glume 1.2-1.8 mm long, elliptic, 5-nerved, apex acuminate with short hairs. Upper glume 3.5-4 mm long, elliptic-lanceolate, 7-nerved, cuspidately acuminate. Lower lemma similar to upper glume, empty, 9-nerved, paleate. Upper lemma 2.5-3 mm long, hermaphrodite, elliptic-oblong, coriaceous, 3-nerved, white, shining, obtuse; palea similar to the upper lemma. Lodicules 2. Stamens 3; anthers up to 1.5 mm long. Caryopsis up to 3.2 mm long (Fig. 1).

Specimens examined: Mirzachowki, Sahibganj district, *R. R. Jha* 7892.

Distribution: INDIA: Bihar; Burma, Malaya.

Ecology: Along railway tracks, open grasslands; rare.

Flowers: August – December.

ACKNOWLEDGEMENT

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36. SOME NOTES ON GRASSES OF BIHAR

During routine collection of grasses from different places of Bihar, we came across four taxa, namely *Dactyloctenium aristatum* Link., *Digitaria stricta* Roth ex Roem. et Schult. var. *stricta*, *D. stricta* var. *denudata* (Link.) Henr. and *D. sanguinalis* (L.) Scop. var. *purpurea* Haines which have not been earlier reported from Bihar. These taxa show great variation in their morphology. The detailed description of the taxa is available in literature hence in the present paper only critical notes of the plants have been included after the citation. The identity of all collected specimens have been confirmed at Central National Herbarium (CNH), Howrah and voucher specimens are deposited at Bhagalpur University Herbarium, Bhagalpur.

Dactyloctenium aristatum Link. Hort. Berol. 1: 59. 1827; Bor in Gr. Burma, Ceylon, Ind. & Pak. 489. 1960; Patunkar in Gr. Marth. 233. 1980; Babu in Herb. Fl. Dehra Dun 599. 1977. *Eleusine aristata* sensu Hook. f. Fl. Brit. Ind. 7: 296. 1896. pro parte.

Earlier Bor (l.c.), Babu (l.c.) and Patunkar (l.c.) reported the occurrence of this plant from Uttar Pradesh and Maharashtra respectively. The plant shows similarity with *D. aegyptium* (L.) P. Beauv., but it can be easily distinguished from it due to non- stoloniferous culms and solitary spike. Rolla S. Rao and Kanodia (1963) reported it from Barmer and Jaisalmer district (Rajasthan) and the same has recently been collected from Madhya Pradesh (Jain 1966). However, Hemadri (1980) reported that *D. aristatum*, a native of N.E. Africa is rare in India and the material collected by Rao and Kanodia appears to be a misidentification for the dwarf form of *D. aegyptium*. The same view is also expressed by Babu (l.c.). In view of the above facts, the present collection of this taxon from Gandhigram of Godda district of Bihar (R.R. Jha 6349) is interesting and needs further critical study in the field and the herbarium.

Digitaria stricta Roth ex Roem. et Schult. var. **stricta** Syst. Veg. 2: 474. 1817; Bor in Gr. Burma, Ceylon, Ind. & Pak. 305. 1960; Patunkar in Gr. Marth. 142. 1980. *Paspalum royleanum* Nees ex Thw. Enum. Pl. Zeyl. 358. 1864. nomen et in Hook. f. Fl. Brit. Ind. 7: 18. 1896. *Digitaria royleana* (Nees ex Thw.) Prain, Bengal Pl. 1182. 1903; Haines in Bot. Bih. & Oris. 3: 1055. 1961 (Repr. ed.).

Bor (l.c.) created three varieties within *D. stricta* complex, namely var. *stricta*, var.

glabrescens and var. *denudata* and Henrard (1950) into two species, namely *D. stricta* Roth ex Roem. et Schult., and *D. denudata* Roth ex Roem. et Schult., on the presence of upper glume in the former and absence in the latter. Recently Hemadri (1980) merged *D. denudata* with *D. stricta*. After a critical examination of materials (Rajmahal, Mokim 1497, CAL; Mirzachowki, *R.R. Jha* 7022; Angwali, *R.R. Jha* 7283) in fields as well as in herbarium, we found that two population exist in our area and these have been given variety status following Bor (l.c.).

Digitaria stricta Roth ex Roem. et Schult. Syst. Veg. 2: 474. 1817. var. **denudata** (Link.) Henr. Mongor. Digitaria 175. 1950; Bor in Gr. Burma, Ceylon, Ind. & Pak. 306. 1960. *D. denudata* Link. Hort. Berol. 1: 222. 1827.

Bor (l.c.) reported the plant from Bengal and Nepal. Although Gamble collected this variety from Santhal Pargana division of Bihar (Santhal Pargana, Gamble s.n. CAL acc. no. 10623), but it was not included by Haines (1921-24), Mooney (1950), Jain *et al.* (1975) in their work. The collection of this rare grass again from two places (Gilamari, Sahibganj district, *R R. Jha* 6135; Gandhigram, Godda district, *R. R. Jha* 7069) in Santhal Pargana after a lapse of more than hundred years is interesting.

Digitaria sanguinalis (L.) Scop. var. **purpurea** Haines, Bot. Bih. & Oris. 3: 1054. 1961 (Repr. ed.).

Haines (l.c.) reported it from Neterhat but neither Henrard (1950) nor Bor (1960) gave it a varietal status. This taxon which grows in potato fields is closely allied to *D. cruciata* (Nees) A. Camus but differs in the field by its deep purple culms, leaves and spikelets and villous nodes. Haines (l.c.) stated that lower glume is absent, but it was present in specimens collected from Santhal Pargana (Fojdari, 1 km south of Mirzachowki, Sahibganj district, *R. R. Jha* 6504). The varietal status of this taxa should be kept.

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37. SOME NEW RECORDS OF PTERIDOPHYTES FROM GARHWAL HIMALAYA

During the recent floristic survey and explorations in the remote localities of Garhwal Himalaya, we made some interesting collection of pteridophytic plants. Perusal of literature indicated that these plants had not been collected by earlier explorers from the North West Himalaya including Garhwal region (Beddome 1883, Dhir 1980, Bir *et al.* 1983, Khullar and Sharma 1987, Khullar *et al.* 1987, Pangtey and Punetha 1987).

The present communication includes a short description, habitat, general occurrence, place from where the collection was made with approximate elevation, and the collector's Herbarium number of the newly recorded plant species. The voucher specimens are housed in the Herbarium Department of Botany, HNB Garhwal University, Srinagar (GUH).

ASPLENIACEAE

Asplenium subavenium (Hook.) Bedd. Ferns Brit. India t. 288 1866. Handb. Ferns Brit. India 144. 1883.

Fronds long, lanceolate, coriaceous, very opaque stipe tufted, wiry, black, densely fibrillose. Pinnae numerous, approximate, horizontal, sessile, oblong, obtuse, upper half serrated, base cuneate. Rachis ebony back, rigid, sparsely setose, costa and veins sunk. Sori oblong, oblique, involucre firm, membraneous.

A terrestrial fern growing on moist and shaded rock crevices. Extremely rare, Raath, 2,000 m a.s.l., GUH 12,129.

HYMENOPHYLLACEAE

Crepidomanes latealatum (V. d. Bosch) Copel. Philip. J. Sci. 67: 60. 1938. *Trichomanes latealatum* V. d. Bosch. Ned. Kr. Arch. 5: 138. 1863. *T. bipunctatum* Poir. Encycl. 8: 69. 1808; Bedd. Handb. Ferns. Brit. India 41: 1883.

Rhizome wide-creeping, dark brown, branched, densely hairy. Fronds ovate, tripinnatifid. Stipes nacked, slightly winged above. Main rachis with a narrow wing or free below. Pinnae ovate-rhomboidal, lower pinnule deeply pinnatifid, ultimate segments linear. Texture firm membraneous. Veins a single mid rib to each segment, vainlets diverging with scattered false veins. Sori terminal on segments, tube sunk or somewhat exserted.

Grows in humid shady forests as an epiphyte on mossy tree trunks near streams, also found growing as a lithophyte on moist, shaded rocks. Rare in occurrence. Sutole, Chamoli district, 2,400 m a.s.l. GUH 12,194.

Dryopteris sino-fibrillosa Ching. Bull. Far. Mem. Hist. Biol. 10: 180. 1940; Dhir, Bibliotheca Pteridologica 1: 64. 1980. *Nephrodium fillix-mas* var. *fibrillosa* Clarke, Trans. Linn. Soc. Lond. II. Bot. 1: 520. 1880. *Lastrea filix-mas* var. *parallelogramma* sub. var. *fibrillosa* (Clarke) Bedd. Handb. Ferns. Brit. India 250. 1883.

Fronds very narrow, tapering at both ends, but not attenuated with auricles into the stipe. Stipe and main rachis densely scaly. Pinnae patent, cut down to the mid rib, segments oblong-obtuse, serrulate at the apex, fibrillose on the surface beneath.

A high altitude terrestrial fern, growing on moist, densely shaded and humus rich forest floor. Uncommon in occurrence, Har- Ki-Doon, 2,400 m a.s.l. GUH 12,099.

NEPHROLEPIDACEAE

Nephrolepis cordifolia (L.) Prestl. Tent. Pterid. 79. 1836, Clarke, Trans. Linn. Soc. Lond. II. Bot. 1: 540. 1880, Bedd. Handb. Ferns Brit. India 282. 1883, Bir *et al.* PFGH 52. 1983. *Polypodium cordifolium* L. Sp. Pl. 2: 1089. 1753.

Caudex sub-erect, roots often bearing tubers. Stipes tufted, wiry, slightly scaly. Pinnae imbricated, blunt, margins entire, or slightly crenate. Rachis scaly, glabrous. Texture coriaceous. Sori midway between the mid rib and margin. Indusium persistent, reniform.

A terrestrial fern often replaced by cultivated forms and growing on dry and exposed rocky hill slopes. Rare in occurrence. Panyatal, Gadera 1,100 m a.s.l. GUH 12,089.

OLEANDRACEA

Oleandra undulata (Willd.) Ching. Lingnan. Sci. J. 12: 565. 1933. *O. cumingii* J. Smith. Hook. Sp. Fil. IV. 158, Bedd. Ferns Brit. India t. 135. 1866, Clarke Trans. Linn. Soc. Lond. II. Bot. 1: 542. 1880. Bedd. Handb. Ferns Brit. India 288. 1883.

Caudex creeping, thick, scaly. Fronds firm, membranaceous, elongate, lanceolate, acuminate, attenuated, gradually decurrent at the base, pubescent-villous on the costa and veins. Stipes subterminal, sub-aggregated, articulated. Sori quite close to the mid-rib.

Grows as an epiphyte on tree trunk of *Quercus semecarpifolia* in the forests or as an lithophyte on exposed rocky walls. Rare, Pidola, and Bhasar, 2,100 m a.s.l. GUH 12,103.

DAVALLIACEAE

Araiostegia clarkei (Bak.) Copel. Philip. J. Sci. 34: 241. 1927, Dhir, Bibliotheca Pteridologica 1: 57. 1980. *Davallia clarkei* Bak. Hook. & Bak. Syn. Fil. 91. 1874. *Hencostegia hookeri* (Moore) Bedd. Hanb. Ferns. Brit. India. 52. 1883.

Rhizome stout, scales dense, golden. Fronds deltoid, 3-4 pinnatifid. Stipe slender, base scaly.

Lower pinnae opposite or attunate, lanceolate or deltoid. Pinnules deltoid, ultimate segments acute, 1-veined. Texture membranaceous. Sori at the base or ultimate lobes. Indusium broad, persistent, membranaceous.

Growing as an epiphyte on *Cedrus deodara* tree trunks in the forests. Very rare in occurrence. Mandoli Chamoli 3,000 m a.s.l. GUH 12,424.

ACKNOWLEDGEMENT

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38. CONTRIBUTION TO THE FLORA OF MANIPUR

The main noteworthy work on the botany of Manipur state is by Deb (1961 a, b). He made intensive collection and published a list of 2007 taxa of flowering plants. After Deb's comprehensive works, Shukla and Baishya (1979) added 66 species of plants from Manipur.

The present work is based on my collections in different parts of Manipur during 1990-91. *Ambrosia, Arthraxon, Bergia, Centipeda, Crassocephalum, Cryptocoryne, Lasia, Paramygnya, Spiranthes* are new genera for the state. The family Elatinaceae is a new addition to the flora of Manipur.

In the following enumeration species are arranged alphabetically within the genera and the families which are also arranged alphabetically. For each species locality and field numbers have given. Local names are also given as far as possible.

AMARANTHACEAE

Cyathula capitata Moq.— Sparsely hairy herb. Leaves elliptic, subcaudate acuminate. Heads globose. Lokchao. HB. 5368.

ARACEAE

Cryptocoryne spiralis Fisch.—Herbs with creeping rootstock. Leaves linear lanceolate, spathe sessile, tube short obconic. Keibullamjao. HB. 835.

Lasia spinosa (Linn.) Thwaites —Herbs with thick prickly rhizome. Leaves hastate, prickly on the nerves beneath. Spathe purple thick, open at the base.

LOCAL NAME: *Wakhie yendem.* Tender leaves are used as a vegetable. Moreh. HB. 5511.

ASCLEPEDIACEAE

Cynanchum wallichii Wight—Twining, glabrous. Leaves ovate lanceolate finely acuminate, peduncle shorter than the petioles, pedicels slender. Khongkhang. HB. 5563.

ASTERACEAE

Ambrosia artemisiafolia Linn.—Herbs with furrow stem. Leaves pinnatifid, with narrow segments. Chandel. HB. 3386.

Centipeda minima (Linn.) A. Br. & Asch. — Prostrate herb with numerous stem from the base. Leaves small oblanceolate or obovate. Head small subsessile, yellow. Moreh. HB. 5215.

Conyza angustifolia Roxb.—Hairy and villous herb. Leaves sessile, linear, bracts many. Tengnoupal. HB. 3622.

Crassocephalum crepideoides (Benth.) Moore — Herbs. Leaves alternate, pinnatifid. Heads discoid. Moreh. HB. 5215.

Eupatorium birmanicum DC.—Herbs with glabrous stem. Leaves lanceolate margin serrately lobed. Heads blue.

LOCAL NAME: *Langthrei. Komlathabi.* HB. 3361.

BALSAMINACEAE

Impatiens tomentosa Hayne—Simple erect more or less clothed with crisp refuscent hairs. Leaves short, uniform, obtuse or acute, more or less scabrid or tomentose.

LOCAL NAME: *Khujang.* Chandel. HB. 5399.

I. verticillata Wight—Glabrous erect herb. Leaves opposite, narrow lanceolate, flowers umbelled, lip boat shaped, spur straight or incurved at the tip.

LOCAL NAME: *Khujang.* Keibullamjao. HB. 839.

COMMELINACEAE

Commelina clavata Clarke—Glabrous or puberulous sparingly branched. Leaves ovate or lanceolate, spathes peduncled, ovate lanceolate.

LOCAL NAME: *Wangdengkhoibi.* A good fodder. Awangkhul. HB. 633.

CYPERACEAE

Carex indica Linn. — Stout woody rootstock. Stem trigonous leafing upwards, margins scabrid, lower sheaths compressed. Lokchao. HB. 5342.

Cyperus cyperoides (Linn.) O. Kuntze — Perennial herbs with short creeping rhizomes. Spikelets in simple umbels and spirally arranged. Chakpikarong. HB. 5592.

ELATINACEAE

Bergia capensis Linn.— Glabrous herb with procumbent rooting. Leaves elliptic lanceolate, stipules narrowly deltoid. Keibullamjao. HB. 3340.

GENTINIACEAE

Swertia nervosa (G. Don) Clarke —Herbs with 4-winged or lineolate stem. Leaves elliptic lanceolate, 3-nerved, panicles many flowered. Ukhrul. HB. 3631.

LAMIACEAE

Gomphostemma wallichii Prain — Stout herb, densely tomentose. Leaves elliptic ovate, serrate, densely tomentose beneath. Tengnoupal. HB. 5572.

Salvia saxicola Wall. — Herb with woody rootstock. Radical leaves long petioled, broad, oblong-lanceolate. Flowers in panicles.

LOCAL NAME: *Yenakhat.* Keibullamjao. HB. 5513.

MALVACEAE

Hibiscus cannabinus Linn. —Prickly, stem glabrous. Leaves palmately lobed, petioles prickly. Corolla yellow.

LOCAL NAME: *Shougri.* Keibullamjao. HB. 2101.

MIMOSACEAE

Albizia myriophylla Benth. — Woody climbers. Leaflets 25-50 pairs, closely crowded. Heads small. LOCAL NAME : *Yang-li.* Lokchao. HB. 5349.

ORCHIDACEAE

Spiranthes lancea (Thunb.) B.B. & v. S. — Plant grows in swamps, small. Leaves linear. Flowers spirally arranged on the scape, flower greenish white. Keibullamjao. HB. 5609.

POACEAE

Arthraxon lanceolatus (Roxb.) Hochst. — Slender herbs, culms decumbent. Leaves large, ovate lanceolate to linear lanceolate. Keibullamjao. HB. 5595.

Cyrtococcum accrescens (Trin.) Stapf — Perennial, culms tall. Leaves linear lanceolate. Spikelets arranged in open or contracted panicles. Keibullamjao. HB. 2114.

Panicum sanguinales Linn. — Stem erect, stout. Leaves very variable, fascicled. Spikelets loosely or closely imbricate. Chandel. HB. 3310.

POLYGONACEAE

Polygonum glabrum Willd. — Stout herb with woody rootstock. Leaves linear lanceolate, glabrous. Inflorescence spiciform panicled racemes. Keibullamjao. HB. 3220.

RUTACEAE

Paramygnya armata Oliv. — Scandent Shrub, glabrous. Leaflets elliptic or elliptic lanceolate. Flowers small solitary or fascicled. Chandel. HB. 5516.

VACCINIACEAE

Vaccinium griffithianum Wighti. — Small shrub. Leaves oblong or elliptic lanceolate, serrulate, sparsely hairy beneath. Chandel. HB. 2130.

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39. ADDITION TO THE FLORA OF ORISSA — I

Cuttack, one of the 13 districts of Orissa lies between 20°1′ N and 21°10′ N latitudes and 84°58′ E and 87°3′ E. The forest cover of this district is 1056 sq. km (Mishra 1981). Haines (1921-25) the pioneer plant explorer of Bihar and Orissa collected 125 angiospermic taxa only from cuttack district. Mooney (1950) added 68 species to the previous compendium. After this work, floristic studies in this district was practically nil except a few sporadic reports made by the workers like Patnaik (1956), Patnaik and Chayu Patnaik (1956), Panda and Choudhury (1984) and Mohanty and Choudhury (1984). Realising the unexplored nature of this district a survey programme was undertaken under the auspices of P.G. Department of Botany, Utkal University since 1987. Up till now 989 angiospermic taxa under 595 genera belonging to 132 families have been collected, preserved and housed in the P.G. Department of Botany, Utkal University, Bhubaneswar. After scrutiny of available literature, 3 taxa turned out to be new records for the state of Orissa. Correct nomenclature, short diagnostic characters, phenology, locality of collection, notes on ecology and distribution of these taxa have been provided. Identifications of all taxa have been confirmed at Central National Herbarium (CNH), Calcutta.

Hibiscus talbotii (Rakshit) Paul & Nayer, Bull. Bot. Surv. Ind. 22. 198. 1980. Saldanha et Ramesh, in Saldanha Fl. Karnataka 1: 252. 1984. *Hibiscus hirtus* L. var. *talbotii* Rakshit, Sci. &Cult. 27: 193. 1961. (MALVACEAE).

Erect herbs, up to 0.75 m. high. Branches densely silky. Leaves long-petioled, ovate, lobed, sserrate, 4-6 x 3-5 cm, obtuse, pubescent beneath, absence of gland beneath, 3-nerved from base; petioles larger than lamina. Fls. axillary, solitary, long-peduncled, white. Epicalyx present. Sepals and Corolla densely silky.

Fls. & Frts: December-June.

Specimens examined: Godishai (Cuttack). *H.N. Subudhi*, 13607. Confirmed with *Talbot* 68, Acc. No. 54871 Holotype (CAL).

Distribution: South West India.

Ecology: Growing in dry areas along the verge of roads.

Vahlia digyna (Retz.) Kuntze, Rev. Gen. Pl. 227, 1891; Ramesh in Saldanha Fl. Karnataka 1: 366. 1984. *Oldenlandia digyna* Retz. Obs. Bot. 4: 23. 1786. *Vahlia viscosa* Roxb. Fl. Ind. 2: 89. 1832;

Haines. Bot. Bihar and Orissa 2: 356. 1961 (Repn. Edn.). (VAHLIACEAE)

Erect, densenly branched herbs. Leaves opposite, 1-2 x 0.3-0.5 cm, lanceolate, apiculate, densely pubescent all over. Fls. in subsessile, axillary clustered cyme, 5-merous. Fls. white, slightly exserted than calyx. Styles 2, connate at base. Capsules dehiscent apically, many-ovuled.

Fls. & Frts. February - May.

Specimens examined: Baliput (Cuttack), Mahanadi River Bank, *H.N. Subudhi*, 13590. Haines (l.c.) has not cited any locality from Orissa. Confirmed with *K.M. Sebastine*, 9820 (CNH).

Illustration: Saldanha Fl. Karnataka 1: 366. f. 58A. 1984.

Distribution: INDIA; Ceylon, Persia, Egypt, Tropical Africa.

Nesaea brevipes Koehne, Bot. Jahrb. Syst. 3: 326. 1882, Matthew, Fl. Tam. Carnatic 3(1): 610. 1983. (LYTHRACEAE).

Herbs up to 20 cm high. Leaves elliptic-oblanceolate, 1.5-2.5 x 0.6-1.0 cm, glabrous, base sub-amplexicaul, apex subacute. Fls. axillary cymes, subsessile. Sepals pinkish, ciliate. Petals absent. Seeds many, ovoid.

Fls. & Frts: January-May.

Specimens examined: Baliput, (Mahanadi river bank), *H.N. Subudhi*, 6633. Confirmed with *Biswas*, 114 (CNH).

Illustration: Matthew, Illus. Fl. Tam. Carnatic f. 181. 1982.

Distribution: Deccan peninsula, East Bengal; Sri Lanka.

Ecology: Growing in marshy places along river banks.

ACKNOWLEDGEMENTS

We are grateful to Prof. & Head, P.G. Department of Botany, Utkal University for providing laboratory facilities and to the authorities of Department of Science, Technology & Environment, Govt. of Orissa for providing financial assistance to the senior author to carryout this piece of work.

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40. FIVE NEW ADDITIONS TO THE FLORA OF KARNATAKA

Floristically Karnataka has been well studied by many authors. Important floristic work goes back to late 19th and early 20th centuries. Cooke (1909-1910) and Talbot (1909-1911) covered the northern parts which include the districts of Shimoga, North Kanara, Belgaum, Dharwar and Bijapur while Gamble (1915-1936) covered the southern parts of the state.

Besides those reported in several short papers, more detailed studies of the vegetation of many districts have been taken up in recent years. They include *The flora of Bangalore District* by Ramaswamy and Razi (1973), *Flora of Hassan District* by Saldanha and Nicolson (1976), *A Synoptic Flora of Mysore District* by Rao and Razi (1981), *Flora of Chikmagalur District* by Yoganarasimhan *et al.* (1983) and *Flora of Coorg* by Keshavamurthy and Yoganarasimhan (1990). In addition to these, Singh (1988) published *Flora of Eastern Karnataka* covering eight districts. In between Sharma *et al.* (1984) brought out an analysis which takes into account all papers published until then and relevant to Karnataka. Flora of Karnataka (Vol. 1) by Saldanha covering all the districts also appeared in 1984.

Under the scheme 'Vegetation map of South India', French Institute of Pondicherry made several ecological inventories, especially along the Western Ghats (Pascal 1988). During such inventories five species were found to be new additions to the flora of Karnataka. However, their distribution by ecological zones is more significant than by administrative demarcations. Four of the five species, were recorded from Kodagu (Coorg) District alone. This region with dryness of 4-5 months is subject to bioclimatic conditions more or less prevailing in the northern part of Kerala. Many species characteristic of evergreen forests of Kerala are found to extend up to the Coorg region which may also be the northern most limit for such species.

A brief description of the specimens collected, updated nomenclature, phenology and some notes on ecology and distribution of the five species have been provided in this paper.

DIPTEROCARPACEAE

Dipterocarpus bourdilloni Brandis in J. Hooker, l.c. Pl. t. 2403. 1896, Gamble, Fl. Madras 1: 58. 1957 (re. ed).

Trees often reaching 45 m height. Flush densely tomentose. Stipule large, up to 14 x 2 cm, stellate tomentose without, glabrous within, caducous leaving annular scar at nodes. Petiole 3.5-7 cm long; lamina ovate to elliptic-ovate, 6-45 x 9-28 cm acute to acuminate at apex, rounded to subcordate at base, stellate pubescent beneath, glabrous above; secondary nerves 16-26 pairs. Inflorescence panicle. Fruit nut-like with 2 calyx lobes accrescent (16 x 3 cm, 3 nerved and reticulate); fruiting calyx tube 5-winged.

Specimens examined: Kodagu District : Kadamakkal R.F., Sampaje range, *B.R. Ramesh* 1007.

Fruits: November.

To the south of the Palghat gap in the Western Ghats, where the number of dry months varies from 2 to 4, *Dipterocarpus bourdilloni* is generally confined to low altitudes, up to 600 m North of the Palghat gap with the number of dry months 4-5, it shows disjunct distribution. Some isolated patches were encountered near Mukkali (Palghat Dt.) and Carcoor Ghat (Cannanore Dt.) of Kerala. A patch was also found near Uppangala in Kadamakal Reserved Forest which may be the northernmost limit in the distribution of this species.

EBENACEAE

Diospyros bourdillonii Brandis, Indian Trees 435. 1906; Gamble, Fl. Madras 2: 547. 1957 (re. ed.).

Trees 25 m high. Bark black. Petiole 0.6 to 1 cm long, lamina 6.5-18 x 2-4.5 cm, narrow-elliptic to oblong sometimes oblanceolate, bluntly acute to acuminate at apex, acute to attenuate at base; secondary nerves 6-9 pairs; tertiary nerves nearly percurrent and horizontal to the midrib. Flowers dioecious, 4-5 merous. Male flowers in axillary cymes or on old wood; calyx hairy without, 8 mm long; corolla cream, tubular, to 9 mm long with reflexed lobes; stamens 12-18 in subequal pairs. Female flowers in cymose clusters on old wood, hairy; pedicel to 1.5 cm long; calyx broader at the middle, 9 mm long, lobes acute; corolla cream, tube 9 mm long and broader at the middle, lobes reflexed; staminodes 10-11; ovary hairy. Fruit woody, globose to broadly ovoid, 7 cm across, glabrous; fruiting calyx, pentagonal.

Specimens examined: Kodagu District: Kadamakal Reserved Forest, Sampaje Range, *B.R. Ramesh* 1018, 1334, *D. Franceschi* 189; Makut forest, *D. Franceschi* 219.

Flowers: February; **Fruits**: November.

An endemic, cauliflorous tree in the evergreen forests on the windward side of the Western Ghats, found between 300 and 1000 m elevations. Present record in Karnataka is the northernmost limit for this species.

Diospyros nilagirica Bedd., l.c. t. 136. 1834, Clarke in J. Hk. Fl. Brit. India 3: 566. 1882; Gamble, Fl. Madras 2: 545. 1957 (re. ed.)

Trees reaching up to 20 m. Flush densely ferruginous tomentose. Petiole to 1 cm long; leafblade 6.5-18 x 2-4.5 cm narrow elliptic to narrow oblong, sometimes oblanceolate, acute to acuminate at apex, acute to attenuate at base, glabrous when old; secondary nerves 6-9; tertiary nerves obscure. Fruits axillary solitary globose, to 2.5 cm across. 8-celled; albumen not ruminate.

Specimens examined: Kodagu District: Gallibedu, Mercara taluk, *J.P. Pascal* 859.

Fruits: March.

It is mostly confined to evergreen forests at the medium elevation (850-1500 m) in the Western Ghats. Generally in its area of distribution, the number of dry months varies from 2 to 4. In Kerala it has been recorded in Pirmed, Thekkadi - Devicolam, and Munnar (all Idikki District). In Tamil Nadu it has been found in the High Wavy mountains, the Anamalais and the Nilgiris. Near Gallibedu, it is rare and has been encountered along the margins of the sholas at 1100 m elevation.

Diospyros affinis Thw. Enum. Pl. Zeyl. 179. 1860. Beddome, l.c. 127. 1871 Clarke in J. Hk. Fl. Brit. India 3: 566. 1882; Gamble, Fl. Madras 2: 544. 1957 (re. ed.).

Trees to about 10 m in height. Petiole 4-10 mm in long; Leaf blade narrow elliptic to elliptic lanceolate, 5-9 x 1.7-3.2 cm obtuse to subacute at apex, acute to attenuate at base, sparsely puberulous when young; secondary nerves 8-10 pairs, lowermost 2 pairs generally close and acute in angle; reticulation obscure especially on upper surface in mature leaves. Male inflorescence axillary cymes of 3 to 10 sessile flowers, calyx pilose 4-lobed; corolla tubular, cream, densely pilose without, glabrous within, 1.1 cm long, 4-lobed; stamens 12 in unequal pairs, connectives slightly hairy on the back; pistillode densely pilose. Fruits globose elliptic 1.5 cm across, seeds 4; endosperm ruminate.

Specimens examined: Mysore District, Kollegal Division, Madeshwaramalai Reserved Forest, *B.R. Ramesh* 1230, near Odayarapalya, Edyarhalli Reserved Forest, *B.R. Ramesh* 705.

Male flowers: June; Fruits: January.

Notes: *Diospyros affinis* is a common species in the drier zones of Sri Lanka (Kostermans 1981). Beddome (1871) reported this species from Tirunelveli hills. However, after his report, there are no subsequent collections either in Tirunelveli region or in any other part of India. In our recent survey we have located this species not only in the Tirunelveli hills (in Mundanthurai sanctuary) but also in Dharmapuri Division (Mulakkadu R.F., Chitteri R.F. and Thirthagiri) in the northern part of Tamil Nadu and in the Kollegal Division of Karnataka. It is, however, only occasionally encountered in all these regions and is found along dry stream beds in dry deciduous forests.

FABACEAE (FABOIDEAE)

Kunstleria keralensis C.N. Mohanan & N.C. Nair, Proc. Indian Acad. Sci. (Plant Sci.) 90: 207. 1981.

Liana with scaly bark. Leaves imparipinnate, 5-7 foliolate, rachis 3-13 cm long; leaflets 8-18.5 x 3-6.5 cm, elliptic-oblong to lanceolate, caudate-acuminate with blunt tip at apex, acute to rounded at base, chartaceous; secondary nerves 4-7 pairs; reticulation prominent, deeply impressed above and strongly raised beneath. Pods in panicles, to 12 x 3.5 cm, oblong, flat, reticulate, seeds single, 4 x 2.2 cm flat, kidney shaped.

Specimens examined: Kodagu district; Kadamakal R.F., Sampaje range, *D. Franceschi* 460 B.

Fruits: February.

Kunstleria keralensis, a new genus recorded for India and a new species in the genus has been described by Mohanan and Nair (1981) based on the collection from Quilon District, Kerala. Although, in our survey, this species was commonly found throughout the low and medium elevations in the evergreen forests of the Western Ghats from South Kerala up to Agumbe (Shimoga Dt., Karnataka), we could not identify this earlier due to the lack of reproductive material. However, we have included this species in our vegetative key (Pascal and Ramesh 1987) as an unidentified liana.

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ERRATA

Vol. 89 (3)

Wintering Waterbirds at Point Calimere, Tamil Nadu

on p. 324, Fig. 1

For 1 cm = 100 birds (100-1200)
Read 1 cm = 200 birds (200-2400)

Vol. 90 (1)

Miscellaneous Note No. 28. On an interesting collection of *Bauhinia* (Leguminosae : Caesalpinioideae) from Arunachal Pradesh.

on p. 120,

For Fig. 1. *Bauhinia tenuiflora* Watt ex Clarke.
a. Fruiting twig; b. Seed. Scale = 1 cm.
Read Fig. 1. a. Fruiting twig; b. Seed. Scale = 1 cm.

For Fig. 2. Scanning photo-micrograph of *Bauhinia tenuiflora* (x 800).
Read Fig. 2. Scanning micrograph of seed surface (x 800).

Left column, paragraph 2,

For given here (Fig. 2) to facilitate identification in the field.
The identity of specimens can be determined by
Read given here with an aim to draw the attention of the research workers
so that the identity of the specimen can be determined in future by

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Hornbill House, S. B. Singh Road, Bombay 400 023.

108th Annual Report

Report of the Executive Committee for the year ended 31 March 1992

During the year 1st April 1991 to 31st March 1992, the Executive Committee met 24 times. The various Sub-committees also met periodically and provided the needed advice to the Executive Committee. The Advisory Committee members also gave advice on several issues concerning the Society's activities.

Mr Bittu Sahgal, who was elected as the Honorary Treasurer in March 1990, resigned his post in July 1991. In his place, Dr A N D Nanavati was elected as the Honorary Treasurer.

On the retirement of Mr J C Daniel as Director of the Society on 31st March 1991, Dr Robert B Grubh was made the Acting Director from 1.4.1991. Mr J C Daniel was elected Honorary member of the Society. Dr Jay S Samant joined the Society in December 1991 as Director.

The newly elected Executive Committee for the years 1992 and 1993 met on 14.3.1992 for the first time. This Committee included two members who were nominated by the Committee in terms of the amended Rules and Regulations.

It was indeed the Society's privilege that Shri R Venkatraman, the then President of India, kindly consented to become the Patron of the Society.

The Salim Ali Centre for Ornithology and Natural History (SACON) started functioning at Coimbatore in November 1991 as an autonomous body of the Ministry of Environment, Forests and Wildlife. A Joint Research Advisory Council has been formed with three representatives each from BNHS and SACON to formulate and implement scientific projects. The first Annual General Meeting of the SACON was held at Hornbill House in March 1992.

During the year, the Society suffered serious losses in the demise of Mr Rajiv Gandhi, our Patron, Dr P J Deoras, a former Executive Committee member, Mr J G Bodhe, Consulting Engineer to the Society and Dr R M Naik, a former member of the Advisory Committee.

The activities undertaken by the Society during the year through various Sub-Committees are indicated below :

COLLECTIONS SUB-COMMITTEE

Chairperson	Mr M R Almeida
Members	Mr H Abdulali Dr B F Chhapgar Dr Meena Haribal Mr Nitin Jamdar Mr Andy Mendonsa Mr N D Mulla
Honorary Secretary	Mr Ulhas Rane
Honorary Treasurer	Mr Bittu Sahgal
Acting Director	Dr Robert B Grubh (1.4.91 to 9.12.91)

Director	Dr Jay Samant (from 10.12.91)
Staff members	Mr A G Sekar Mr Manoj Muni Dr (Mrs) S Unnithan
Convenor	Mr N Chaturvedi

Air-conditioning of the 'Collections' Rooms and rearranging the 'Collections' were completed during the year. The Society is thankful to M/s Batliboi & Co. Ltd. for completing and commissioning the unit and to the BEST authorities for the prompt supply of electricity to run the unit.

All the specimens in the Collections were periodically cleaned and checked throughout the year.

The Parliament Committee, Gen. S F Rodrigues, Chief of Army, Ms Bakul Patel, Sheriff of Bombay and Dr A P Jamkhedkar, Director of Archives and Museum, Govt. of Maharashtra visited the Collections.

Mammals Section

Work of computerisation of the card-index data was continued.

The 'Collections' department assisted students and members in their studies on certain species and identification of specimens. A collaborative project on resurvey of 'Mammals of India' was initiated with the Harrison Zoological Museum (HZM) of U.K. Pilot study projects on 'Fruit Bats of Bombay' and 'Hair structure study of Indian Mammals' were undertaken during the year.

Reptiles & Amphibians Section

This year 1100 collection data has been appended in the computer. During a trip to Matheran in July 1991, 17 specimens were collected. Based on their analysis, two papers were submitted for publication in the Journal.

One of the scientists presented a paper at the First International Conference of the IUCN/ Species Survival Commission - Indian Subcontinent Reptile and Amphibian Specialist Group, held at Bhubaneswar, in February 1992.

Birds Section

The catalogue of some specimens of birds in BNHS Collection was published in the Journal.

Entomology Section

200 specimens of butterflies collected from Kerala by a member were received. Specimens of bugs, beetles, butterflies, dragonflies, lacewing flies and insects collected on Leea plant were identified. A tag with the message 'Inform BNHS' was designed and attached individually on butterflies to study their migration. Four papers were published/accepted for publication in the journal.

Herbarium Section

Data on 2050 specimens was entered into the computer.

177 new herbarium sheets were prepared and registered (specimens collected from Manas Wildlife Sanctuary).

Bharatpur (Keoladeo) Ecology Project's collection of plants was added to the 'Collections'.

LIBRARY SUB-COMMITTEE

Chairperson	Dr Ashok Kothari

Members	Dr B F Chhapgar Dr P R Saraiya Mr P R Cama Mr Kiran Srivastava Ms Doreen D'Sa
Hon.Secretary	Mr Ulhas Rane
Hon.Treasurer	Mr Bittu Sahgal
Acting Director	Dr Robert B Grubh (1.4.91 to 9.12.91)
Director	Dr Jay Samant (from 10.12.91)
Convenor	Mr Isaac Kehimkar

The renovation of the Library has given it the much deserved facelist. The segregated air-conditioned 'Reference' section has provided the much needed security for the old and rare books.

The Society organised an exhibition of rare books, which received enthusiastic response not only from members but also from the press and public. A proposal to computerise the library has been approved by the Executive Committee.

At the end of March 1992, the books in the library stood at 11,790 (including bound volumes of periodicals). In 1991, in all 168 books were added to the library - 8 books were received from the publishers for favour of review in the Journal, 32 were received as complimentary/donation and 128 books were purchased for the library and various projects.

MEMBERSHIP AND PROGRAMMES SUB-COMMITTEE

Chairperson	Dr (Ms) Meena Haribal
Members	Mr S D Bhaumik Dr Ashok Kothari Mr Sunjoy Monga Mr C B Mehta Dr Parvish Pandya Mr S A Hussain Mr P B Shekar
Hon. Secretary	Mr Ulhas Rane
Hon. Treasurer	Mr Bittu Sahgal
Acting Director	Dr Robert B Grubh (1.4.1991 - 9.12.1991)
Director	Dr Jay Samant (From 10.12.1991)
Convenor	Mr N Chaturvedi

The membership at the end of December 1991 was as follows :

	Year		
Type of membership	1989	1990	1991
Ordinary members	1521	1413	1638
Corporate members	82	60	75
Life members	1269	1304	1476
Compound Corporate members	113	113	113
Student members	225	237	416
Honorary members	3	4	4
Vice Patrons	4	4	4
Centenary Life members	3	3	3
Family members	-	-	46

Although the membership has increased in 1991 as compared to 1990, there is need to increase it substantially. A questionnaire was sent to members in August 1991 to find out their desired involvement/liking in various activities of the Society. The replies received are being looked into.

Annual Nature Camps at Sikkim and sanctuaries in South India were organised.

Overnight weekend camps were arranged at Bhimashanker, Sacred Grove, Bhandardhara, Lohgad Fort near Lonavala, Suryamal, Dapoli, Kanchad Forest, Supa Farm, Ulhas and Vaitarna valleys. A nature trek was organised from Amboli to Dodamarg. Weekend outings were arranged at IIT campus, Powai, Borivli National Park, Tungareshwar, Palasdari lake, Tulsi lake, Kanheri Cave, Bhoj lake and Karnala Bird Sanctuary. A waterfowl count was conducted at Powai lake and Elephanta Island.

A quiz programme on Indian Wildlife was conducted during the Wildlife Week. The members also participated in a walk for conservation of the Asiatic Lion. Several scientific lectures, slide shows and films were arranged for the benefit of members and local public.

On the occasion of the birth anniversary of Dr Salim Ali on 12.11.1991, the Mayor of Bombay, Mr Diwakar Raote named the traffic island near Hornbill House as 'Padma Vibhushan Dr Salim Ali Chowk'. We are grateful to Municipal Corporation of Greater Bombay for permitting us to maintain the island and to Mr S P Godrej for helping the Society in putting up the garden.

A Charity Film Show was arranged in January 1992 to raise funds for the Society. A souvenir was also released on the occasion by Ms Bakul Patel, Sheriff of Bombay. We are thankful to all advertisers, donors and members for their patronage and encouragement. Mr T V Sowrirajan played an important role in this activity.

A photographic competition and exhibition was held during February-March 1992. A total of 361 colour prints and 462 colour slides were viewed by a Panel of Judges consisting of Mr Sharad Devare, Mr R A Acharya and Mr Sunjoy Monga. The Society is grateful to the judges for adjudging the prize winners..

NATURAL HISTORY STUDIES SUB-COMMITTEE

Chairman	Dr Erach Bharucha
Members	Prof. P V Bole Dr B F Chhapgar Mr M R Almeida Dr A M Bhagwat Dr Shashi Menon Mr Rishad Naoroji Mr Bharat Bhushan
Hon.Secretary	Mr Ulhas Rane
Hon.Treasurer	Mr Bittu Sahgal
Acting Director	Dr Robert B Grubh (1.4.1991 - 9.12.1991)
Director	Dr Jay S Samant (From 10.12.1991)
Convenor	Mr S A Hussain (till January 1992)

During the year, the Sub-Committee funded the following projects:

Salim Ali Loke Wan Tho Scholarships

1. **Ecological and behavioural studies of the Indian Black Ibis at Rajkot - Ph D Programme - Scholar : Mr Sachin Vyas - Guide - Dr V C Soni, Department of Biosciences, Saurashtra University, Rajkot.**

   This study was to survey the microhabitats of the Indian Black Ibis for foraging and feeding.

2. **Feeding and breeding ecology of the Openbilled Stork in Andhra Pradesh** - Ph D Programme - Scholar: Ms Mehrab Johnson - Guide: Dr J V Ramana Rao, Department of Zoology, Osmania University, Hyderabad.

   Population estimation by visual counts and photographic evidence for behavioural traits were obtained.

3. **The study of the bird life of scrub in the forests in and around Delhi** - M Sc Thesis - Scholar : Mr Vivek Menon, New Delhi - Guide: Dr R B Grubh, BNHS.

   This study surveyed the bird species in the study area, and identified habitat preferences of birds in four areas.

Education and Research Fund

1. **Floristic studies in the Sanctuaries of Orissa** - Scholar: Dr B P Choudhary, Professor of Botany, Utkal University, Orissa.

   A survey of plants in some parks and sanctuaries were conducted.

2. **Survey and natural history observations on the Amphibian Fauna around Sringeri** - Scholar : Mr S V Krishnamurthy - Research Supervisors - Dr Katre Shakuntala and Dr S Ravichandra Reddy, Professors, Dept. of Zoology, Bangalore University.

   Surveys were conducted in many localities around Sringeri and specimens were collected.

Plant Studies Fund

Pilot studies for ecological survey of Borivli National Park - Scholar : Mrs Sashi Rekha Iyer, BNHS Member. A survey of all the plants in the Borivli National Park was conducted.

Projects initiated with seed money

1. **Study of the Guindy National Park - Its Habitat Evaluation for Conservation Strategies** - Scholar : Madras Naturalists Society.

   Habitat evaluation of the Park was done and a total of 80 quadrats was studied.

2. **Ecology and Behaviour of Lampyridae around Pune** - Scholar : Ms Varsha Karekar, University of Poona.

   A general survey was made of ecological conditions and the population densities of Lampyridae were studied.

Ongoing Projects

Pirojsha Godrej Fund

1. **A study of the Danaine Butterflies** - Scholar: Dr (Ms) Meena Haribal, BNHS.

Education and Research Fund

2. **Documentation of Insect Fauna of the Borivli National Park** - Mr Naresh Chaturvedi, BNHS.

NATURE EDUCATION SUB-COMMITTEE

Chairperson	Dr Parvish Pandya
Members	Mrs Sadhana Rasal Dr Sanjay Bhagwat Mrs Bijoor Mr Shreekant Pol Dr Arun Joshi Mr Vilas Shingre Mr Unmesh Brahme
Hon.Secretary	Mr Ulhas Rane

Hon.Treasurer	Mr Bittu Sahgal
Acting Director	Dr Robert B Grubh (1.4.1991 - 9.12.1991)
Director	Dr Jay S Samant (From 10.12.1991)
Convenor	Mrs Shailaja R Grubh

A circular on Society's Nature Education activities was sent to about 500 schools in and around Bombay inviting their participation in the programmes. During the year, approximately 7,000 students took advantage of different programmes. Apart from students, nearly 100 teachers and 150 trainee teachers participated in the training programmes on Environment Education. Besides, the programmes have reached rural areas of Maharashtra, Army and Navy personnel and colleges in Tamil Nadu.

World Forestry Day Programme

To commemorate the World Forestry Day, a quiz programme was organised in February 1992. A painting competition was also organised for school children at different levels.

Environmental Awareness Course

This course with the theme "Ponds and Forests for Prosperity and Posterity" was conducted in January 1992 at Nagercoil, Kanyakumari Dt. Professors, lecturers and students from many colleges were attended the course. The course was conducted through the generous funding by the Ministry of Environment, Forests and Wildlife, Government of India and Asian Wetland Bureau, Kuala Lumpur, and the Society wishes to thank them for their help.

Activities for Scouts

Some students were examined for the proficiency badges (friends to animals). A talk illustrated with slides on 'Our Common Birds' was arranged for the Scout and Girl Guide Instructors at Bharat Scouts and Guides.

Other Camps

The Institute for Psychologically Handicapped, Thane, Bombay and Indradhanu, Pune, had organised survey camps for students. A talk illustrated with slides was arranged for them. A slogan competition was held as a part of the Earth Summit in collaboration with the British Council. 100 students from Marathi Vidnyan Parishad at Pune/Bombay were shown the Society's collections and were introduced to Nature Education activities. 42 field trips to Borivli National Park and 3 to Karnala were conducted during the year.

Students were taken to the Prince of Wales Museum (14 visits), Victoria Gardens (6 visits) and Taraporewala Aquarium (10 visits). During the year 6 new schools were introduced to the Nature Education Scheme. 5 talks were given on All India Radio on Nature Education.

PERSONNEL SUB-COMMITTEE

Chairperson	Mr Kisan Mehta (till 17.4.1991) Dr A N D Nanavati (from 18.4.1991)
Members	Mrs D S Variava Vice Adm M P Awati (Retd.) Dr P R Saraiya
Hon.Secretary	Mr Ulhas Rane
Hon.Treasurer	Mr Bittu Sahgal

Acting Director	Dr Robert B Grubh (1.4.91 to 9.12.91)
Director	Dr Jay Samant (from 10.12.1991)
Convenor	Mr S V Ramakrishnan

During the year under review after extensive discussions with the staff of the Society, the Employees Service Rules were introduced, effective from 1.1.1991. The pay structure of staff was also revised as from 1.1.1991. The other important actions taken by the Sub-Committee were a) re-utilisation of services of staff attached to Projects at Bharatpur and Pt.Calimere that ended in June 1991, b) recruitment to some posts including that of the Director and c) taking up on Leave & Licence basis a flat at Gokuldham in Goregaon (E) as dormitory accommodation for BNHS staff.

PRODUCT SUB-COMMITTEE

Chairman	Maj Gen E D'Souza (Retd)
Members	Mr Sunjoy Monga Mr Ajay Varadachary
Hon.Secretary	Mr Ulhas Rane
Hon.Treasurer	Mr Bittu Sahgal
Acting Director	Dr Robert B Grubh (1.4.1991 - 9.12.1991)
Director	Dr Jay S Samant (From 10.12.1991)
Convenor	Mr J Rodrigues

The Sub-Committee attended to the usual sale of greeting cards and calendars. Few additional products like caps, T-shirts and coffee mugs were introduced during the year. A renovated sale counter has been put up for prominent display of Society's products.

In May 1992, the Society put up a stall in the Exhibition organised by Kuchi Mahila Sangh, where the Society's publications and products were displayed.

PROJECTS SUB-COMMITTEE

Chairperson	Vice Adm M P Awati (Retd)
Members	Dr A N D Nanavati Mr M R Almeida Mr K P Karamchandani Dr Shashi Menon Mr J C Daniel Mr S A Hussain Dr V S Vijayan
Honorary Secretary	Mr Ulhas Rane
Honorary Treasurer	Mr Bittu Sahgal
Acting Director	Dr Robert B Grubh (1.4.91 to 9.12.91)
Director	Dr Jay Samant (from 10.12.91)
Convenor	Dr Robert B Grubh (from 1.4.91 to 19-3-92) Mr S R Nayak (from 20.3.92)

During the year, the BNHS handled 6 major field ecological research projects. The progress of research work under each of these projects is detailed below:

1. Bird Migration Project

Research activities were carried out at Point Calimere (Tamil Nadu), Sriharikota (Andhra Pradesh), and Chhari Dhand (Kutch, Gujarat). Field team from Point Calimere conducted short term ringing camps at Kodaikanal in the Western Ghats to monitor fall and spring migration of passerines as well as altitudinal movements of birds of the area.

Study of the populations and migratory patterns of birds of the Eastern Ghats and study of the bird communities of Sriharikota Island were started.

2. Elephant Ecology Project

Current year's study at Mudumalai and Denkanikotta (Tamil Nadu) and Dalma (Bihar) laid emphasis on population dynamics, the size of the elephant population in the study area, the population trend in the study area and the impact of poaching of males on the populations. Ranging behaviour and social organisation and behaviour of the elephants was also studied. Information on grass dynamics, habitat utilisation by elephants, elephant habitat interaction and ecological significance of critical microhabitats were analysed.

3. Birds of Prey Project

Surveys for raptors were conducted in various sanctuaries and national parks of South, Central and Northern India. Four resident species of raptor were found in Buxa, Nokrek and Balpakram National Parks. The most interesting find of the survey was the sighting of the nesting pair of Redfooted Falcon in the Jaggau forest outside the Namdapha National Park. The bird was reported nesting in North Cachar in 1928 and since then there was no record of it.

Raptor trapping method was demonstrated during a workshop organised with experts from USFWS at Banni Grasslands (Gujarat). In Corbett National Park, previously unrecorded facts of behaviour were observed on the Lesser Greyheaded Fishing Eagle and Serpent Eagles.

4. Grassland Ecology Project

On the Principal Investigator of the Project joining the Aligarh Muslim University (AMU) in June 1991, the Project was implemented jointly by BNHS and AMU with the approval of the GOI and USFWS. Based on the research programme undertaken by the BNHS earlier on the Great Indian Bustards, Lesser and Bengal Florican, three types of grassland habitats have been studied and surveyed in some detail. Field stations were established at Dudwa, Nanaj and Jaisalmer.

5. Point Calimere Ecology Project

The Project ended on 30th June 1991. The draft Report has been prepared.

6. Bharatpur (Keoladeo) Ecology Project

The project ended on 30th June 1991. The summary report on the project was released in July 1991 at Bombay.

7. Bird Hazard Research Cell

The Cell continued its activities through the kind funding by AR&DB, Ministry of Defence, Govt. of India. The AR&DB also sponsored the visit of Dr S M Satheesan, to the 21st meeting of the Bird Strike Committee, Europe, held at Jerusalem, Israel, in March 1992.

PUBLICATIONS SUB-COMMITTEE

Chairman	Mr Bittu Sahgal
Members	Dr B F Chhapgar Mr Sunjoy Monga
Hon.Secretary	Mr Ulhas Rane
Hon.Treasurer	Mr Bittu Sahgal
Acting Director	Dr Robert B Grubh (1.4.91 to 9.12.91)

Director	Dr Jay Samant (from 10.12.91)
Convenor	Mr Ajay Varadachary

Demand for various titles, in particular The 'Book of Indian Birds' was reprinted during the year; several other books will be taken up for reprinting subsequently.

The *Hornbill* continues to be well received by members. The change to a larger format has permitted the inclusion of more matter as well as more attractive layouts, with the traditional emphasis on photographs and illustrations.

Funding for the BNHS-NCSTC Hornbill series of booklets on different aspects of wildlife and the environment has been received from the Department of Science & Technology, Government of India, and work on the series is in progress. A total of 36 booklets will be produced in English and regional languages. The Pictorial Guide has been extensively revised, with the addition of textual descriptions, distribution maps, more detailed identification characters, etc. The book will be produced in collaboration with the Guide Book Co. of Hong Kong.

SALIM ALI NATURE CONSERVATION FUND SUB-COMMITTEE

Chairperson	Mrs D S Variava
Members	Mr H K Divekar Mr Rusi Engineer Mr J C Daniel
Hon. Secretary	Mr Ulhas Rane
Hon. Treasurer	Mr Bittu Sahgal
Acting Director	Dr R B Grubh (1.4.91 to 9.12.91)
Director	Dr Jay S. Samant (from 10.12.91)
Convenor	Mr Bharat Bhushan (up to August 1991) Mr Goutam Narayan (September 1991 onwards)

1. Research projects funded

a. Large Dams

A sum of Rs.30,000/- was given to Kalpavriksha, a Delhi based voluntary organisation, to support a project entitled Post Construction Evaluation of Large Dams. Detailed studies at three dams were carried out and a preliminary report on one dam site was prepared.

b. Sharavati and Pooyamkutty

SANCF had received requests from activists in Sharavati valley in Karnataka and Pooyamkutty in Kerala who are concerned about the planned hydroelectric projects in these areas. One of the former BNHS scientists has surveyed the areas and submitted report on Sharavati. The report on Pooyamkutty study is under preparation.

c. Blacknecked Cranes in Bhutan

A sum of Rs. 10,000 was sanctioned to a member for a study of Blacknecked Cranes in Bhutan. The report gives the current status of the cranes in Bhutan.

d. Bhimashankar

The research project on wildlife-people conflict at Bhimashankar Sanctuary was completed. Follow up action was initiated with Maharashtra state government.

2. **Networking and Documentation**

Publications and clippings on environmental conservation received from Centre for Education and Documentation, Centre for Science and Environment, Forum for Environmental Journalists (FEJI), Kerala Forest Research Institute etc., are being maintained by SANCF and they are available with BNHS library.

3. **Seminars, Training Workshops and Lectures**

a. Public Hearing and Preparations for UNCED

A Public Hearing on Environment and Development was organised in Bombay by SANCF on 16 -17 November 1991 as part of preparations for NGO participation in the UNCED (Earth Summit) at Rio. The discussion focused on wildlife and nature conservation, policies and framework for sustainable development, urban development and industrialisation, and concept of big dams with special reference to Sardar Sarovar Project.

On 28 January 1992, a talk on global perspective of some agenda items for UNCED - 'Eco-politics' - was arranged.

b. Dr Sálim Ali Memorial Lecture

On the occasion of Dr. Sálim Ali's 95th birthday on 12 November 1991, a lecture on the environmental problems of the Andaman and Nicobar Islands was delivered by Rev. Fr. Cecil J. Saldanha.

c. Armed Forces Cell

The Society committed itself to hold training workshops for Army officers during the Army Chief's visit to BNHS on 20 December 1991. An Armed Forces Cell was constituted and five workshops - one for each Command of the Army will be held during the course of next one year.

4. **Environmental Issues**

a. Andamans

Those present during Dr Sálim Ali's birthday function passed a resolution expressing their concern for the preservation of natural resources of the Andaman islands and recommending certain remedial actions. The Society is in touch with the Ministry of Environment and Forests regarding the conservation actions on the islands.

b. Narmada

Several meetings of the environmental activists on Narmada project were organised at the Society during the year.

c. Darlaghat

The decision of the government to denotify a part of the Darlaghat Sanctuary was a matter of concern for the SANCF. A team from the Society's Environment Impact Assessment Cell visited the site.

UNIVERSITY STUDIES SUB-COMMITTEE

Chairman	Prof. P V Bole
Members	Mr M R Almeida Dr B F Chhapgar Prof. Parvish Pandya Dr Shashikumar N Menon Mr J C Daniel Dr V S Vijayan

Hon.Secretary	Mr Ulhas Rane
Hon.Treasurer	Mr Bittu Sahgal
Acting Director	Dr R B Grubh (1.4.91 to 9.12.91)
Director	Mr Jay Samant (from 10.12.91)
Convenor	Mr N Chaturvedi

Dr Jay Samant took over as Head of the BNHS University Department since January 1992.

Zoology

An application has been made to the University of Bombay, requesting them to increase the number of seats for M.Sc. (by Research) and Ph.D. degree in Zoology.

The details of students who qualified/are working for higher degree are given below:

a) Students who completed Ph.D.

Name of the Student	Name of the Guide
Mr Ravi Sankaran	Mr J C Daniel
Mr T Sunderamoorthy	-do-

b) Students who have submitted synopsis for Ph.D.

Name of the Student	Name of the Guide
Mr Goutam Narayan	Mr J C Daniel
Mr Ranjit Manakadan	-do-

c) Students working for Ph.D. degree

Name of the Student	Name of the Guide
Mr Bharat Bhushan	Mr J C Daniel
Mr Prakash Rao	-do-
Mr Alagar Rajan	Dr Robert B Grubh

d) Students registered for Ph.D.

Name of the Student	Name of the Guide
Mr N Chaturvedi	Mr J C Daniel
Mr N K Ramachandran	-do-

e) Student who has submitted thesis for M.Sc. (by Research)

Name of the Student	Name of the Guide
Mr Shahid Ali	Mr J C Daniel

f) Students who continue to work for M.Sc. (by Research)

Name of the Student	Name of the Guide
Mr Gurmeet Singh	Dr Robert B Grubh
Mr Vivek Menon	-do-
Mrs Nikita V Mathur	Mr J C Daniel

Botany

The term of temporary recognition given by University of Bombay to the Society for guiding students for M.Sc. (by Research) and Ph.D. in Botany expired in June 1992. An application has been sent to the University seeking permanent recognition to the Society for awarding the degrees.

Student who continued to work for M.Sc. (by Research)

Name of the Student	Name of the Guide
Ms Neelam Patil	Mr M R Almeida

Donations:

The following donations were received during the year :

Received from	Donation For	Amount Donated Rs.	Total Rs.
Mr Hasmukh Desai	Library	5,000	5,000
M/s. Merind Ltd.	Hornbill	10,000	10,000
From Estate of late Dr Salim Ali	SANCF Corpus Fund	7,00,000	
M/s. Bharat tiles Ltd.		10,000	7,10,000
Balvikas Nursery	SANCF Revenue Fund	300	
Mr Chaitanya M Desai		251	
Mr Bittu Sahgal		200	751
Dr Sugato Choudhary	Charles McCann Vertebrate Fieldwork Fund	600	600
Mr R E Funkerton (Australia)	Staff Welfare Fund	35	35
Mr T V Sowrirajan	Charity Film Show	5,660	
Dr R M Captain		2,000	
Dr Meena Haribal		1,560	
Mrs Saver L Shah		720	
Dr Ashok Kothari		700	
Dr Abdul Karim Naik		500	
Dr A N D Nanavati		400	11,540
Mrs Leela Dayal	Rare Books Exhibition	300	
Box Collections		2,180	2,480
Indian Hotels Co. Ltd.	Dr Salim Ali Memorial Fund	1,00,000	
Air Freight Ltd.		50,000	
Dr (Ms) Yvonne Artaud		4,000	
Mr Indravadan Mehta		4,000	
Mr Sunil Zaveri		2,500	
Mr Pramod Surte		1,250	
Shri Enterprises		1,000	
	Carried over	1,62,750	7,40,406

Brought over	1,62,750	7,40,406
Ms Thrity M Badami	500	
Mr Naresh Chaturvedi	443	
Hirdwani Trust	250	
Prof. A Vadmoni	120	
Mr Debi Goenka	50	
Mr Chaitanya M Desai	50	
Mr S K Guha	20	
Mr Nabab Murtaza Ali Khan	20	
Mr Kamal Prasad	16	1,64,219
	Grand Total Rs.	9,04,625

ACKNOWLEDGEMENTS

The Executive Committee acknowledges with thanks the assistance given to the Society by the Ministry of Environment, Forests and Wildlife and the Ministry of Defence of the Government of India, the United States Fish and Wildlife Services, the Government of Maharashtra, the Charity Commissioner, Bombay, the 'A' Ward Officer of the Municipal Corporation of Greater Bombay, the authorities of the Prince of Wales Museum of Western India, the concerned officers of various state governments where Society's research stations are functioning, the bankers, the British Dy.High Commission, and US Consular Office. It also thanks the several donors, committed members and dedicated staff for their wholehearted support in the various activities of the Society.

Meena Haribal
Honorary Secretary

Bombay 400 023.
23 November, 1992.

HONORARY TREASURER'S REPORT FOR THE YEAR ENDED 31ST MARCH 1992

The following points need to be highlighted while considering the Accounts and Auditor's report for the year 1991-92.

a) Income by way of sale of books, calendars and greeting cards declined from Rs. 8.2 lacs to Rs. 3.9 lacs, resulting in a lower operating surplus.

b) The total funds owned by the Society went up by Rs. 22.08 lacs as follows :

i)	Increase in Life Membership Fund	Rs. 1.99 lacs
ii)	Increase in Corpus Fund (Schedule A)	Rs. 7.10 lacs
iii)	Increase in other funds (Schedule B)	Rs. 12.99 lacs
		Rs. 22.08 lacs

The increase of Rs. 12.99 lacs under (iii) above may be compared with the corresponding figure of Rs. 7.77 lacs for the previous year.

In view of the financial situation obtaining now, the fundraising efforts need to be stepped up considerably in the coming days.

C G Wakankar
Honorary Treasurer.

Bombay 400 023.
9 January 1993

HABIB & CO.
Chartered Accountants

Patharia Place
75, Mohamedali Road,
Bombay 400 003.

Date : 09.01.1993

AUDITORS REPORT

Re: BOMBAY NATURAL HISTORY SOCIETY
(Registration No.F-244 Bom)

We have audited the attached Balance Sheet of the Society as at March 31, 1992 and also the annexed Income & Expenditure Account for the financial year ended on that date and report that in our opinion and to the best of our information and according to the explanations given to us:

(a) The accounts are maintained regularly and in accordance with the provisions of the Bombay Public Trust Act, 1950 subject to the observation that as per past practice separate Receipts & Payments Account has been drawn for the Nature Education Scheme and the same has not been incorporated in the accounts of the Society. In this context, we observe that as per the accounts so drawn up, a sum of Rs.1,02,966.87 is considered to be due from the Nature Education Scheme as at the end of the year. We have been given to understand that on settlement of the claim for arrears of the grant from the government, the entire amount would be adjusted.

(b) The receipts and disbursements have been properly and correctly shown in the accounts, subject to the observations made in other paras.

(c) The cash balance and the vouchers in the custody of the accountant on the date of audit were in agreement with the books of accounts.

(d) The books, deeds, accounts, vouchers and/or other documents or records required by us were produced to us.

(e) The register of movable and immovable properties has been maintained. However, the changes therein have remained to be communicated to the Regional Office. In the context of the equipments and other such capital items acquired out of the various grants and other project funds, we observe that initially the cost of such equipments etc. is charged to the relevant project accounts and on completion of the projects, the Society generally seeks the permission of the concerned sponsoring authorities to retain such assets as are found to be useful for other projects and/or purposes and on obtaining such approvals, the necessary entries are passed in the books of accounts to record the residual value of such items. We observe that pending such approval, the Society is actually utilising a number of such capital assets including vehicles for other projects. It will be appreciated, if the matter is followed up with the concerned authorities to regularise the matter and to bring into account the value of such assets. We have been given to understand that a record of such assets is being separately maintained by the project officers.

(f) The Dy.Director (Accounts) appeared before us and furnished the necessary information required by us.

(g) We are not aware of any property or funds of the Society having been applied for any objects or purpose other than the objects of the Society.

(h) The following items were outstanding for more than one year:

Dues towards Supplies & Services	19,992.05
Loans to staff	15,475.00
Advance for expenses	29,300.00
Other dues	41,130.05

Included under the head 'other dues' are certain expenses amounting to Rs.12,433.75, which have been incurred in connection with certain projects and pending certain clarification sought from the concerned sponsoring authority have remained to be adjusted. Included under the said head is a sum of Rs.6,534/- considered to be due from the Bihar State Government, which is being carried forward for the last few years. Considering the age of the said outstanding the recovery thereof is not free from doubts. The matter may be reviewed and if the said amount be considered to be irrecoverable, the same may be written off. During the year under report a sum of Rs.3,441/- representing dues considered irrecoverable has been written off. We have been assured that the other outstanding balances are considered good and realisable.

We also observe that a small difference of Rs.175.30 noticed in the books of accounts has been charged to Income & Expenditure a/c. The same may also be confirmed in the next meeting of the Managing Committee. Incidentally, it may be stated that included under the head 'advances to employees for project and other expenses' are the amount of two remittances aggregating to Rs.8,199.25 made per Demand Drafts, which are stated to have been lost in transit. We are informed that the matter is being followed up with the concerned Bank. Pending the outcome of the enquiries,the said amount is considered good.

(i) The renovation work of the building in occupation of the Society, which was taken up in the earlier year was completed during the year. The expenditure incurred during the year on that count amounted to Rs.25,755.75. The work, as stated in our last report accompanying the statement of accounts for the year ended 31/3/1991, was carried out through a building contractor. No tenders were called for the said work. However, as stated in our last report, limited quotations had been called for from certain contractors and the contract was awarded to the concerned contractor on his quotation being approved.

(j) We are not aware of any money of the Society having been invested in contravention of Sec. 35 of the Bombay Public Trust Act, 1950.

(k) We are not aware of any immovable property of the Society, therefore, the question of alienation of any property contrary to the provisions of Sec. 36 of the Bombay Public Trust Act, 1950 does not arise.

(l) i) In regard to the expenses charged to various grants and funds we have relied on the information given to us and the authentication of the Hon.Secretary and Hon.Treasurer that the expenses so charged relate to these grants and have been spent on the specific objects for which the grants were received. While checking the statement of accounts in regard to the expenditure incurred at various camps, we have relied on the authorisation by the Hon.Secretary and Hon.Treasurer, as to the reasonableness of the expenditure.

ii) We observe that during the year under report the Ecology of Keoladeo Ghana Sanctuary Project was completed and the expenses incurred on the said project during the year aggregated to Rs.8,40,626.70, which interalia include Rs.38,012.50 incurred towards transportation expenses of some of the item of furniture and equipments etc. from Bharatpur to Bombay and with unspent grant of Rs.6,82,143.95 brought forward from the earlier year, the said account shows a debit balance of Rs.1,58,482.75 as at the close of the year, which has been carried forward. We understand that though the project was completed during the year, the compilation of the report and other summing up process of the study carried out was pending and a further sum of Rs.1,66,606/- has been incurred during the current year upto 31/10/92 in that connection. We are informed that the necessary approval is being sought from the sponsoring authorities for retaining the assets that have been so received back from the project site and on obtaining the requisite approval the estimated value of the said items shall be brought into account as per the accounting policy adopted by the Society as outlined in para (e) hereinabove and the balance, if any, in the account shall be accordingly adjusted in the current year.

iii) While on the above subject, we observe that some of the local field workers, whose services were engaged for the said project at Bharatpur, are claiming reinstatement and other service benefits, which is being disputed by the Society. The contingent liability in this regard remains undeterminate. The matter, we are informed is pending before the Labour Court at Bharatpur and Provident Fund authorities.

iv) We observe that in respect of the total expenditure of Rs.15,07,248/- incurred towards air-conditioning of library and collection rooms at Hornbill House, the Society had received a grant of Rs.9,00,000/- upto 31/3/92 from the Central Govt. A further amount of Rs.4,92,187/- has been sanctioned by the Ministry of Environment & Forests in the current year towards the said expenditure. The same has been accounted in the current year, as the sanction letter was received much after the close of the financial year.

v) We observe that during the year advance of Rs.71,905/- for purchase of equipments and accessories, which was being brought forward from the earlier years has been adjusted during the year. We are informed that the imported material was received in the preceding year and was issued for the purpose of Bird Migration Project and accordingly the said amount has been charged to the relevant Grant a/c., which we suggest may be confirmed at the next meeting of the Managing Committee.

vi) We also observe that during the year under report the advance of Rs.13,500/- paid to Efficient Data Processing Pvt. Ltd. for data processing work of members records has been adjusted. We are informed that though the entire work assigned to them was not completed, the advance paid has been considered to cover the volume of work carried out and the softwares developed by them are being used. The said amount of Rs.13,500/-, as adjusted in the General Expenses, we suggest, may be confirmed at the next meeting of the Mg.Committee.

vii) The income towards membership subscription is being accounted on realisation basis.

viii) The subscriptions received in foreign currency, we observe, are deposited in an account maintained with Grindlays Bank plc., London Branch. The said receipts and disbursements made therefrom have been accounted at the exchange rate prevailing at the date of the Balance Sheet. The closing balance has been translated at the current exchange rate, at the date of the Balance Sheet and the difference in exchange amounting to Rs.19,489.87 has been credited to Income & Expenditure Account. We observe that during the year under report a sum of £.100 equivalent to Rs.4,846/- was credited to the said account. As no proper particulars in respect of the said item were available, the said amount has been credited to Suspense Account. The said Suspense Account as at the date of Balance Sheet shows a balance of Rs.16,793.42, which interalia includes another item of unlinked credit of Rs.1,401/- relating to earlier year. We suggest that effective action may be taken to obtain proper particulars in this regard and the said amounts may be adjusted to proper accounts.

ix) We suggest the following items of disbursements effected, appropriations made and administrative charges levied conferred and ratified at the next meeting of the Executive Committee.

A. DISBURSEMENT FROM :

i)	Salim Ali Nature Conservation Fund Investment Revenue Account	1,63,034.01
ii)	Salim Ali / Lok Wan Tho Ornithological Fund Investment Revenue Account	31,883.52
iii)	Pirojsha Godrej Foundation Fieldwork Fund Investment Revenue Account	2,778.46
iv)	Col.Burton Nature Conservation Fund Investment Revenue Account	86.12
v)	Charles McCann Vertebrate Zoology Fieldwork Fund	766.87

vi)	Shri M Y Ghorpade of Sandur Photography Exhibition Fund	8,898.40
vii)	Education & Research Fund created out of Income	27,541.90
viii)	Salim Ali Memorial Fund	15,000.00
ix)	Staff Gratuity Fund	616.00
x)	Staff Welfare Fund	1,450.00
xi)	Donation from Seth Purshotamdas Thakurdas & Divaliba Charitable Trust for Library Books and Furniture	25,000.00
xii)	Ministry of Defence, ARDB, for Bird Hazard Research Cell	1,19,337.85
xiii)	Ministry of Defence, ARDB, travel grant for attending Seminar in Israel	57,033.00
xiv)	Ministry of Environment & Forests for air-conditioning Library and Hornbill House	1,43,450.00
xv)	Ministry of Environment & Forests for the project "A Study of the Habitat requirement of the Rusty Spotted Cat and other Endangered Wildlife of the Dang Forest" by Dr E K Bharucha	59,703.42
xvi)	Ministry of Environment & Forests, Indian Environmental Society for Environmental Awareness Campaign 1991-92	30, 000.00
xvii)	Grant from U.S. Department of Interior, Fish and Wildlife Service for :	
a)	Ecology of Dry Grassland	7,51,365.45
b)	Ecology of Keoladeo Ghana Sanctuary, Bharatpur, Rajasthan	8,40,626.70
c)	Ecology of Indian Elephants	11,51,473.05
d)	Ecology of Point Calimere Sanctuary	3,11,204.65
e)	Study of the Migration patterns of Indian Birds and Avifauna Migration Study Data Bank	18,93,421.55
f)	Study of Conservation of Birds of Prey with particular emphasis upon restoration of Endangered Species	10,94,278.87
g)	Habitat and Population Dynamics of Wolves and Blackbucks	23,065.00
xviii)	Govt. of Madhya Pradesh for Indira Sarovar Hydro-electric Project	500.10
xix)	Smithsonian Institution, Washington, for revision of 'The Handbook of Birds of India and Pakistan'	67,077.25
xx)	Neyveli Lignite Corporation Limited for Environmental Study at Rajasthan Plant	1,59,805.80
xxi)	Gujarat Ambuja Cement Co. Ltd. for Environmental Study	3,862.00
xxii)	National Organic Chemical Industries Limited for Environmental Study	19,128.55

xiii)	Asian Wetland Bureau for Environmental Awareness Campaign 1991-92	23,539.51
xxiv)	Grant Govt. of Maharashtra for 1991-92 towards Establishment, Building Maintenance, Educational activity (i.e. Journal printing expenses)	2,15,000.00
xxv)	Grant Indian National Science Academy for the Publication of Journal	5,000.00

B. APPROPRIATIONS :

i)	Salim Ali Nature Conservation Fund	7,10,000.00
ii)	Salim Ali Nature Conservation Fund Investment Revenue Account	751.00
iii)	Charles McCann Vertebrate Zoology Fieldwork Fund	600.00
iv)	Salim Ali Memorial Fund	3,14,219.00
v)	Publication Fund - BNHS	91,159.89
vi)	Publication Fund from Govt. of India, Dept. of Science & Technology	4,871.18
vii)	Addition to Fixed Assets	16,07,660.81
viii)	General Reserve Fund	1,25,000.00
ix)	Staff Gratuity Fund	2,00,000.00
x)	Staff Welfare Fund	1,366.50
xi)	Fixed Assets Fund towards depreciation on Fixed Assets	3,12,966.83

C. ADMINISTRATIVE FEES

charged to various Grants/Funds for handling the projects etc.	8,42,873.25

While referring to the observations made in para 1 (ii) hereinabove, we suggest that the treatment accorded to the expenses on Ecology of Keoladeo Ghana Sanctuary Project as referred to therein be confirmed in supercession of the resolution passed in the Executive Committee meeting held on 14.11.1992.

x) We observe that the contribution to Employees Provident Fund (both the employees and management contribution) continue to be deposited with the Trustees of a recognised provident fund established by the Society and governed by the rules framed for the purpose. There seems to have been certain amendments to the Employees Provident Fund and Miscellaneous Provisions Act, 1952, whereunder the Society may be considered to be liable not only to transfer the accumulated balance in the Employee's Provident Fund a/c. to the Provident Fund Commissioner Govt. Scheme, but also for the difference in the amount of contribution. We suggest that proper legal opinion may be sought in this regard and needful may be done in the matter. We have been informed that so far no demand has been raised by the Provident Fund Commissioner and hence the liability in this regard remains undeterminate.

(m) So far as is ascertainable from the books of accounts and according to the information and explanation furnished to us by the

Dy.Director (Accounts) and the Hon.Secretary, there were no cases of irregular, illegal or improper expenditure or failure to recover the monies or other properties belonging to the Society or loss or waste of money or other property of the Society, subject to the observations made in para (h) hereinabove.

(n) Provisions of Sec. 31-A of the Bombay Public Trust Act, 1950 and Rule 16-A of the Rules framed under the said Act have been complied with.

(o) The maximum and minimum number of Executive Committee members is maintained having regard to the provisions contained in the rules and regulations of the Society.

(p) There is no specific provisions in the rules and regulations of the Society regarding the holding of the meetings of the Executive Committee.

(q) The minute book recording the proceedings of the meetings is maintained.

(r) No member of the Executive Committee has any interest in the investment of the Society.

(s) No member of the Executive Committee is a debtor or creditor of the Society, subject to the observation that a sum of Rs.1,351.25 was due from three members against bills for certain supplies of publication, etc. The said amount has since been received.

(t) There were no irregularities pointed out in our last report dt.6/9/91 accompanying the statement of accounts for the year ended 31st March, 1991 except the observations made in para (i), the observations whereof have been reiterated hereinabove.

Sd/-
CHARTERED ACCOUNTANTS

Bombay 400 023.
9th January, 1993.

Regn. No. F-244 (BOM)

BOMBAY NATURAL HISTORY SOCIETY

BOMBAY PUBLIC TRUST ACT, 1950
SHEDULE VIII VIDE RULE 17(1)

BALANCE SHEET AS ON 31-3-1992

FUNDS AND LIABILITIES	Rs.	Rs.	PROPERTIES AND ASSETS	Rs.	Rs.
LIFE MEMBERSHIP FUND (INDIVIDUALS)			**IMMOVABLE PROPERTIES**		NIL
Balance As Per Last Balance Sheet	1490715.16				
Add: Received During The Year	199280.00	1689995.16	**INVESTMENTS (AT COST)**		
			5.5% Govt Of India Loan 2000		
CORPORATE LIFE MEMBERSHIP FUND			Of The Face Value Rs.2000/-		
Balance As Per Last Balance Sheet		215742.31	(Market Value Rs.1335/-)	2000.00	
VICE PATRON FUND			6300.381 Units Of Unit Trust Of India		
Balance As Per Last Balance Sheet		42769.00	Under CRTS 1981 Reinvestment Plan		
			Of The Face Value Rs.100/- Each		
CORPUS FUNDS			(Total Face Value Rs.630038.1		
As Per Schedule A		2526174.48	Including Accumulated Units 4300.381)		
			(Repurchase Value Rs.718243.43)	660963.61	
OTHER FUNDS					
As Per Schedule B		8107941.94	70150 Units Of Unit Trust Of India		
			Under Unit Scheme 1964		
CURRENT LIABILITIES			Of The Face Value Rs.10/- Each		
For Unspent Grants			(Total Face Value Rs.701500/-)		
As Per Schedule C	4460648.55		(Repurchase Value Rs.1006652.50)	999637.50	
For Expenses	257189.42				
For Library Deposits	4150.00		4560 Units Of Unit Trust Of India		
For Sundry Credit Balances	188221.53		Under CRTS 1981		
For Advances For Publications			Of The Face Value Rs.100/- Each		
And Products	16303.68	4926513.18	(Total Face Value Rs.456000/-)		
			(Repurchase Value Rs.519840/-)	501600.00	
OTHER LIABILITIES			4400 Units Of Unit Trust Of India		
			Under CRTS 1981		
Amount Received For & On Behalf			Of The Face Value Rs.100/- Each		
Of Proposed Institute :-			(Total Face Value Rs.440000/-)		
Balance As Per Last Balance Sheet	292769.81		(Repurchase Value Rs.501600/-)	506000.00	
Add: Interest Credited					
During The Year	20000.00		4470 Units Of Unit Trust Of India		
			Under CRTS 1981		
	312769.81		Of The Face Value Rs.100/- Each		
Less: Expenditure For & On Account			(Total Face Value Rs.447000/-)		
Of The Institute Including			(Repurchase Value Rs.509580/-)	500640.00	
Rs.23,880/- Transferred					
From SACON A/c.	64683.70	248086.11			
Carried over		17757222.18	Carried over	3170841.11	

FUNDS AND LIABILITIES	Rs.	Rs.
Brought over		17757222.18
Amount Received For & On Behalf Of 'Salim Ali Centre For Ornithology & Natural History' :-		
Balance As Per Last Balance Sheet	375405.75	
Less: Expenses Incurred On Behalf Of SACON	3771.35	
	371634.40	
Add: Expenses Charged In Earlier Year Credited Back	23880.00	
	395514.40	
Less: Amounts Paid To SACON	395514.40	NIL
INCOME & EXPENDITURE ACCOUNT		
Balance As Per Last Balance Sheet	43471.62	
Add: Excess Of Income Over Expenditure During The Year	3216.34	46687.96
Carried over		17803910.14

PROPERTIES AND ASSETS	Rs.	Rs.
Brought over	3170841.11	
50000 Units Of Unit Trust Of India Under US 1964 Reinvestment Plan Of The Face Value Rs.10/- Each (Total Face Value Rs.500000/-) (Repurchase Value Rs.717500/-)	700000.00	
Fixed Deposit With Indian Petrochemical Corporation Ltd.	1500000.00	5370841.11
VEHICLES		
Balance As Per Last Balance Sheet	40566.79	
Less: Depreciation During The Year	8113.36	32453.43
FURNITURE, FIXTURES & EQUIPMENTS		
Balance As Per Last Balance Sheet	831166.95	
Add: Additions During The Year (Including Rs.925000/- Spent From Various Grants/Donations As Per Schedule B)	1607660.81	
	2438827.76	
Less: Depreciation During The Year	304853.47	2133974.29
LOANS		
(Unsecured Considered Good) To Employees		70400.00
ADVANCES		
(Unsecured Considered Good)		
To Employees For Project & Other Expenses	299567.49	
To Others For Project & Other Expenses	67727.60	
For Vehicle Repairs	50000.00	
Advances Against Salaries To Employees	2000.00	
Dues From Nature Education Scheme	102966.87	
Other Dues For Travel And Other Expenses	54163.25	576425.21
Carried over		8184094.04

FUNDS AND LIABILITIES	Rs.	Rs.	PROPERTIES AND ASSETS	Rs.	Rs.
Brought over		17803910.14	Brought over		8184094.04
			DEPOSITS		
			BEST Undertaking	68130.00	
			Mahanagar Telephone Nigam Ltd.	10000.00	
			P & T Dept For Project Telephones	11000.00	
			NCST For Electronic Mailing	1000.00	
			Gas Cylinders For Projects	5950.00	
			Project Accommodations	12396.00	
			MHADA For Staff Quarters Plot	40000.00	
			For Filmshow Entertainment Tax	32500.00	
			Elec Deposits Projects	561.00	
			For Vehicle Fuel Supply	2500.00	184037.00
			STOCKS		
			As Per Inventories Taken And Certified By The Hon.Secretary		
			BNHS Publications	326988.87	
			Govt Publications	41617.80	
			Greeting Cards	88622.35	
			BNHS T Shirts	8635.00	
			BNHS Mugs	3713.00	
			BNHS Caps	2058.00	
			Rare Painting Photographs	3500.00	
			Books Under Publication (Expenses Incurred Till Date)		
			Book Of Indian Birds New Edition	137255.00	
			Some Beautiful Indian Trees	21291.36	633681.38
			INCOME OUTSTANDING		
			Interest Accrued	126992.90	
			For Publications	349895.50	
			For Greeting Cards	46203.60	
			For Calendars	53165.00	
			For Souvenir Advertisements	16600.00	
			For Hornbill Advertisements	24000.00	
			Grants Receivable		
			From US Fish & Wildlife Service	4935925.00	
			From A.R.D.B.	246540.00	
			From Indian Environmental Society	6000.00	5805322.00
Carried over		17803910.14	Carried over		14807134.42

FUNDS AND LIABILITIES	Rs.	Rs.	PROPERTIES AND ASSETS	Rs.	Rs.
Brought over		17803910.14	Brought over		14807134.42
			CASH AND BANK BALANCES		
			As Per Schedule D		2838292.97
			UNADJUSTED DEFICIT ON PROJECTS		
			Keoladeo Ghana Sanctuary Project		
			Expenses Incurred During The Year	840626.70	
			Less: Unspent Balance Of Grant		
			As On 1-4-91	682143.95	158482.75
Total Rs.		17803910.14	Total Rs.		17803910.14

BOMBAY NATURAL HISTORY SOCIETY

AS PER OUR REPORT OF EVEN DATE

Sd/-
J C DANIEL
HON. SECRETARY

Sd/-
C G WAKANKAR
HON. TREASURER

Sd/-
HABIB AND COMPANY
CHARTERED ACCOUNTANTS
BOMBAY

Bombay, Dated 9th January, 1993

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING PART OF THE BALANCE SHEET AS ON 31-3-1992

SCHEDULE A : CORPUS FUNDS

Name Of The Corpus Fund	Balance As Per Last Balance Sheet	Amounts Received/ Appropriated During The Year	Total Of Columns 1 & 2	Balance As On 31-3-1992
	1	2	3	4
Salim Ali Nature Conservation Fund	1361554.96	710000.00	2071554.96	2071554.96
Salim Ali / Loke Wan Tho Ornithological Research Fund	403136.52	-	403136.52	403136.52
Pirojsha Godrej Foundation Fieldwork Fund	40000.00	-	40000.00	40000.00
Col. Burtons Nature Conservation Fund	11483.00	-	11483.00	11483.00
Total Rs.	1816174.48	710000.00	2526174.48	2526174.48

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING PART OF THE BALANCE SHEET AS ON 31-3-1992

SCHEDULE B : OTHER FUNDS

Name Of The Other Fund	Balance As Per Last Balance Sheet	Amount Recd/ Appropriated During The Year	Interest Credited During The Year	Total Of Columns 1, 2 & 3	Transferred To Income & Expenditure Account During The Year	Expenditure On Objects Of Trust/ Other Exps As Shown in Income & Exp. A/c.	Balance As On 31-3-1992
	1	2	3	4	5	6	7
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Salim Ali Nature Conservation Fund Investment Revenue Account	164686.57	751.00	136155.50	301593.07	163034.01	163034.01	138559.06
Salim Ali / Loke Wan Tho Ornithological Fund Investment Revenue Account	63446.74	-	40313.65	103760.39	31833.52	31833.52	71926.87
Pirojsha Godrej Foundation Fieldwork Fund Investment Revenue Account	6728.95	-	4000.00	10728.95	2778.46	2778.46	7950.49
Col.Burton Nature Conservation Fund Investment Revenue Account	2300.63	-	1148.30	3448.93	86.12	86.12	3362.81
Charles MaCann Vertebrate Zoology Fieldwork Fund	96249.82	600.00	9624.98	106474.80	766.87	766.87	105707.93
Sir Dorabji Tata Trust Fieldwork Fund	2233.30	-	-	2233.30	-	-	2233.30
Shri M.Y.Ghorpade Of Sandur Photography Exhibition Fund	10000.00	-	-	10000.00	8898.40	8898.40	1101.60
Plant Study Fund	43774.80	-	-	43774.80	-	-	43774.80
Education & Research Fund Created Out Of Income	90934.36	-	-	90934.36	27541.90	27541.90	63392.46
Chacko Fund For Education And Conservation	37559.70	-	-	37559.70	-	-	37559.70
Salim Ali Memorial Fund	1974210.41	314219.00	-	2288429.41	15000.00	15000.00	2273429.41
Publication Fund - BNHS	1180064.43	91159.89	1271224.32	-	-		1271224.32
Publication Fund From Govt Of India Dept Of Science & Technology	512123.48	4871.18	-	516994.66	-	-	516994.66
Carried over	4184313.19	411601.07	191242.43	4787156.69	249939.28	249939.28	4537217.41

Schedule 'B' Contd.

Name Of The Other Fund	Balance As Per Last Balance Sheet	Amount Recd/ Appropriated During The Year	Interest Credited During The Year	Total Of Columns 1, 2 & 3	Transferred To Income & Expenditure Account During The Year	Expenditure On Objects Of Trust/ Other Exps As Shown in Income & Exp. A/c.	Balance As On 31-3-1992
	1	2	3	4	5	6	7
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Brought over	4184313.19	411601.07	191242.43	4787156.69	249939.28	249939.28	4537217.41
Fixed Assets Fund	738311.51	959976.00	-	1698287.51	312966.83	312966.83	1385320.68
Building Fund	503227.68	-	-	503227.68	-	-	503227.68
General Reserve Fund	547624.02	125000.00	-	672624.02	-	-	672624.02
Staff Gratuity Fund	636925.81	200000.00	-	836925.81	616.00	616.00	836309.81
Staff Welfare Fund	98325.84	1366.50	-	99692.34	1450.00	1450.00	98242.34
Donation From Seth Purshotamdas Thakurdas & Divaliba Charitable Trust For Publication Of Tree Book	75000.00	-	-	75000.00	-	-	75000.00
Donation From Seth Purshotamdas Thakurdas & Divaliba Charitable Trust For Library Books & Furniture	25000.00	-	-	25000.00	25000.00	25000.00	-
Total Rs.	6808728.05	1697943.57	191242.43	8697914.05	589972.11	589972.11	8107941.94

Summary Of Expenditure From Funds/Donations

Expenditure Head	Amount Rs.
Nature Conservation	163034.01
Natural History Study	31173.35
Other Educational	31833.52
Photography Contest & Exhibition	8898.40
Beautification Of Dr.Salim Ali Chowk	15000.00
Cotribution For Staff Trip	1450.00
Depreciation	312966.83
Gratuity Paid To Staff	616.00
Library Furniture	25000.00
Total	589972.11

Details Of Amounts Transferred To Fixed Assets Fund

		Amount Rs.
1.	Grant Govt.Of India D.O.E. For Airconditioning Library And Collection Rooms :- Grant Received Till 31-3-92 And Utilised For The Purpose Including Rs.7,56,550/- Spent During Earlier Years	900000.00
2.	Donation From Seth Purshotamdas Thakurdas & Divaliba Charitable Trust For Library Furniture	25000.00
3.	Surplus On Sale Of Old Car	34976.00
	Total	959976.00

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING PART OF THE BALANCE SHEET AS ON 31-3-1992

SCHEDULE C : GRANTS

Name Of The Grant	Balance As Per Last Balance Sheet	Amount Recd/ Appropriated During The Year	Total Of Columns 1 & 2	Transferred To Income & Expenditure Account During The Year	Expenditure On Objects Of Trust/ Other Exps As Shown in Income & Exp. A/c	Balance As On 31-3-1992
	1	2	3	4	5	6
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
GRANTS FROM GOVT. OF INDIA						
Ministry Of Defence, ARDB, For Bird Hazard Research Cell	137709.06	142540.00	280249.06	119337.85	119337.85	160911.21
Ministry Of Defence, ARDB, Travel Grant For Attending Seminar In Israel	-	104000.00	104000.00	57033.00	57033.00	46967.00
Ministry Of Environment & Forests For Secretarial Assistance To Dr.Salim Ali For Environmental Research Program & Processing Archieval Material	21453.38	-	21453.38	-	-	21453.38
Ministry Of Environment & Forests For Airconditioning Library & Collection Rooms At Hornbill House	143450.00	-	143450.00	143450.00	143450.00	-
Ministry Of Environment & Forests For Purchasing Scientific Equipments During 1988-89 Continued In1989-90	12574.10	-	12574.10	-	-	12574.10
Ministry Of Environment & Forests For Purchasing Equipments During 1989-90	16298.00	-	16298.00	-	-	16298.00
Dept Of Science & Technology For Publication Of Tree Book	51873.10	-	51873.10	-	-	51873.10
Ministry Of Environment & Forests For The Project 'A Study Of The Habitat Requrement Of The Rusty Spotted Cat And Other Endangered Wildlife Of The Dang Forest By Dr.E.K.Bharucha	13545.86	50000.00	63545.86	59703.42	59703.42	3842.44
Carried over	395903.50	296540.00	693443.50	379524.27	379524.27	313919.23

Schedule 'C' Contd.

Name Of The Grant	Balance As Per Last Balance Sheet	Amount Recd/ Appropriated During The Year	Total Of Columns 1 & 2	Transferred To Income & Expenditure Account During The Year	Expenditure On Objects Of Trust/ Other Exps As Shown in Income & Exp. A/c.	Balance As On 31-3-1992
	1	2	3	4	5	6
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Brought over	395903.50	296540.00	693443.50	379524.27	379524.27	313919.23
Ministry Of Environment & Forests Indian Environmental Society For Environmental Awareness Campaign 1991-92	-	30000.00	30000.00	30000.00	30000.00	-
GRANTS FROM UNITED STATES DEPT OF INTERIOR, FISH & WILDLIFE SERVICE FOR RESEARCH PROJECTS						
Hydrobiological (Ecological) Research Project - Keoladeo Ghana Sanctuary Bharatpur, Rajasthan	7617.47	-	7617.47	-	-	7617.47
Ecology Of Dry Grasslands	806008.15	952583.00	1758591.15	751365.45	751365.45	1007225.70
Ecology Of Keoladeo Ghana Sanctuary Bharatpur, Rajasthan	682143.95	-	682143.95	840626.70	840626.70	– 158482.75
Ecology Of Indian Elephant	377312.08	1249743.00	1627055.08	1151473.05	1151473.05	475582.03
Ecology Of Pt.Calimere Sanctuary	394709.17	-	394709.17	311204.65	311204.65	83504.52
Study Of The Migration Patterns Of Indian Birds And Avifauna Migration Study Data Bank	591301.05	1588044.00	2179345.05	1893421.55	1893421.55	285923.50
Study Of Conservation Of Birds Of Prey With Particular Emphasis Upon Restoration Of Endangered Species	1687452.12	1145555.00	2833007.12	1094278.87	1094278.87	1738728.25
Habitat And Population Dynamics Of Wolves & Blackbucks	27721.00	-	27721.00	23065.00	23065.00	4656.00
OTHER GRANTS						
Chief Wildlife Warden Jammu & Kashmir For Survey Of Blacknecked Crane	26111.94	-	26111.94	-	-	26111.94
Govt Of Madhya Pradesh For Indira Sarovar Hydroelectric Project	20078.10	-	20078.10	20078.10	**20078.10	-
Carried over	5016358.53	5262465.00	10279823.53	6495037.64	6495037.64	3784785.89

Schedule 'C' Contd.

Name Of The Grant	Balance As Per Last Balance Sheet	Amount Recd/ Appropriated During The Year	Total Of Columns 1 & 2	Transferred To Income & Expenditure Account During The Year	Expenditure On Objects Of Trust/ Other Exps As Shown in Income & Exp. A/c.	Balance As On 31-3-1992
	1	2	3	4	5	6
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Brought over	5016358.53	5262465.00	10279823.53	6495037.64	6495037.64	3784785.89
Smithsonian Institution, Washington For Revision Of 'The Handbook Of Birds Of India & Pakistan'	168215.22	-	168215.22	67077.25	67077.25	101137.97
World Wide Fund For Publication Of Newsletter	1985.30	-	1985.30	-	-	1985.30
Neyvelli Lignite Corporation Ltd. For Environment Study At Rajasthan Plant (Preliminary Study)	939.50	-	939.50	-	-	939.50
Neyveli Lignite Corporation Ltd. For Environment Study At Rajasthan Plant	-	480000.00	480000.00	159805.80	159805.80	320194.20
Gujarat Ambuja Cement Co.Ltd. For Environmental Study	-	15000.00	15000.00	3862.00	3862.00	11138.00
National Organic Chemical Industries Ltd. For Environmental Study	-	96000.00	96000.00	19128.55	19128.55	76871.45
Asian Wetland Bureau For Environmental Awareness Campaign 1991-92	-	28653.00	28653.00	23539.51	23539.51	5113.49
Total Rs.	5188498.55	5882118.00	11070616.55	6768450.75	6768450.75	4302165.80

Summary Of Expenditure Out Of Grants

Particulars	Amount Rs.
Expenditure On Various Projects Including Capital Expenditure	6605422.65
Capital Expenditure From Grants Transferred To Fixed Assets Fund (Refer To Schedule B)	143450.00
Refund Of Unspent Grants	19578.10
Total Rs.	6768450.75

Total Unspent Balances	Rs. 4460648.55
Less: Overspent On Keoladeo Ghana Sanctuary Project	Rs. 158482.75
	4302165.80

** Includes Refund Of Unspent Grant Rs. 19578.10

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING PART OF THE BALANCE SHEET AS ON 31-3-1992

SCHEDULE D : CASH AND BANK BALANCES

	Rs.	Rs.
A. In Current Account With		
ANZ Grindlays Bank p.l.c. M.G.Road Branch	119783.95	
ANZ Grindlays Bank p.l.c. James Square, London Branch (Sterling Pounds 2229.59 Rs. 48.46 each)	108045.93	227829.88
B. In Savings Account With		
ANZ Grindlays Bank p.l.c. M.G.Road Branch	650862.41	
Bank Of India Museum Savings Branch	18725.77	
State Bank Of India Gateway Of India Branch	3672.31	
Canara Bank Sir P.M.Road Branch	6592.58	
Corporation Bank Dalal Street Fort Branch	3660.68	
Corporation Bank Dalal Street Fort Branch (FCRA Account)	1188.82	
Bank Of Baroda Fort University Branch	760.52	685463.09
C. In Fixed Deposit With		
ANZ Grindlays Bank p.l.c. M.G.Road Branch	1600000.00	
Bank Of India Bombay Main Branch	125000.00	
Corporation Bank Dalal Street Fort Branch	200000.00	1925000.00
	Total Rs.	2838292.97

Regn.No. F-244 (BOM)

BOMBAY NATURAL HISTORY SOCIETY

BOMBAY PUBLIC TRUST ACT, 1950
SCHEDULE IX VIDE RULE 17(1)

INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31-3-92

EXPENDITURE	Rs.	Rs.	INCOME	Rs.	Rs.
EXPENDITURE IN RESPECT			**INTEREST (RECEIVED & ACCRUED)**		
OF PROPERTIES			On Govt Securities	110.00	
Municipal Taxes	4926.00		On Fixed Deposits	576522.39	
Building Insurance	278.00		On Saving Accounts	36273.43	612905.82
Building Maintenance	21845.49				
Renovation Expenses	25755.75	52805.24			
			DIVIDENDS		
			On Units Of UTI Schemes		435117.47
ESTABLISHMENT EXPENSES					
Salaries Of Reference			**DONATIONS**		
Collectons & Maintainace Staff	391478.00		For Specific Purposes :-		
Salaries Of Other Staff	974337.00		SANCF Corpus Fund	710000.00	
Leave Travel Allowances	5437.50		SANCF Revenue Fund	751.00	
Medical Allowances	19250.00		Charles MaCann Fund	600.00	
Washing Allowances	3840.00		Salim Ali Memorial Fund	164219.00	
Management's Contribution To			Staff Welfare Fund	35.00	
Provident Fund	84890.00			875605.00	
Gratuity Paid To Staff	616.00				
Casual Labour	9376.00		For General Purposes :-		
Meeting Expenses	35931.60		Library Expenses	5000.00	
Postage Expenses	24867.80		Hornbill Printing	10000.00	
Printing & Stationery	59770.55		Film Show Expenses	11540.00	
Advertisements	24146.00		Rare Books Exhibition	2480.00	904625.00
Telephone Expenses	43452.86				
Electricity Expenses	12955.80				
Electrical Repairs	5193.70		**GRANTS**		
Travelling Expenses	20025.60		From Govt.Of Maha. For		
Conveyance Expenses	10107.40		Establishment Expenses		
Vehicle Maintenance	30486.69		For 1990-91		
Bank Charges (Net)	6116.64		Collections	91090.00	
Audit Fees	2000.00		Nature Education	47910.00	
Repairs To Furniture			For 1991-92		
& Equipments	68883.65		Collections	215000.00	
Insurance Other Than Building	4473.00				
Professional & Other Fees	41500.00		From Govt.Of India Dept Of		
Annual Report Exps			Science & Technology		
For 1989-90 & 1990-91	67382.50	1946518.29	For Journal Printing	75000.00	
Carried over		1999323.53	Carried over	429000.00	1952648.29

EXPENDITURE	Rs.	Rs.	INCOME		Rs.	Rs.
Brought over		1999323.53	Brought over		429000.00	1952648.29
			GRANTS (Contd.)			
			From Indian National			
MISCELLANEOUS EXPENSES			Science Academy			
Garden Maintenance Exps	5105.00		For Journal		5000.00	
Beautification Of			Other Grants As Per Schedule C			
Dr.Salim Ali Chowk	15000.00		(To The Extent Utilised			
General Expenses	56791.85		During The Year)		6605422.65	7039422.65
Contribution To Staff Trip	1450.00	78346.85				
			SUBSCRIPTIONS			
AMOUNTS WRITTEN OFF			Ordinary Memberships :-			
Bad Debts	3441.00		Individuals		204626.30	
Difference In Books	175.30	3616.30	Family		13086.00	
			Student		11460.00	
DEPRECIATION			Corporate		17140.00	
On Vehicles, Furniture			Life Memberships (Individual)		203280.00	
& Equipments		312966.83	Journal - Members		75151.50	
			Journal - Non Members		86860.70	
AMOUNTS TRANSFERRED TO FUNDS AGAINST INCOME			Entrance Fees		35507.30	647111.80
Specific Purpose Donations						
As Per Contra	875605.00					
Life Membership Fees Fund	203280.00		**INCOME FROM PUBLICATIONS (NET)**			
Nature Education Scheme			BNHS Publications		280359.51	
For 1990-91	47910.00		Govt Publications		4871.18	
BNHS Publication Fund			Greeting Cards		55593.84	
50% Royalty On Dr.Salim			Calendars (Specific Orders)		150103.00	
Ali's Publications	91159.89		BNHS Caps		390.32	
Govt.Publication Fund	4871.18		Old Paintings Photographs		1779.31	
Staff Welfare Fund					493097.16	
Interest On Loans To Staff	1331.50					
Fixed Assets Fund			Less: Deficits On			
Surplus On Sale Of Old Car	34976.00		BNHS Calendars	102217.32		
Interest Allocation To Funds	211242.43	1470376.00	BNHS T Shirts	165.89		
			BNHS Mugs	80.62	102463.83	390633.33
APPROPRIATIONS TO FUNDS OUT OF SURPLUS			**OTHER RECEIPTS**			
Salim Ali Memorial Fund	150000.00		Miscellaneous Receipts		27783.22	
Staff Gratuity Fund	200000.00		Surplus On Members' Camps		73414.95	
General Reserve Fund	125000.00	475000.00	Exchange Fluctuation Surplus		19489.87	
			Royalty On Dr.Salim Ali's Publications		182319.77	
			Surplus On Sale Of Old Car		34976.00	
			Interest On Loans To Staff		1331.50	
Carried over		4339629.51	Carried over		339315.31	10029816.07

EXPENDITURE	Rs.	Rs.	INCOME	Rs.	Rs.
Brought over		4339629.51	Brought over	339315.31	10029816.07
			OTHER RECEIPTS (Contd.)		
EXPENDITURE ON THE			Fund Raising Programme :-		
OBJECTS OF THE TRUST			Net Income From		
Expenses Met Out Of Grants			Filmshow	24568.00	
As Per Schedule C	6605422.65		Souvenir	101611.15	465494.46
Journal Printing & Postage	267841.75				
Hornbill Printing & Postage	213588.18				
Nature Conservation Exps	163034.01		**ADMINISTRATIVE FEES**		
Natural History Study	31173.35		For Project Funds	795802.95	
Nature Education	13244.05		For Govt.Publication Fund	2256.72	
Other Educational Exps	31833.52		For Other Funds	44813.58	842873.25
Members Activities	51833.00				
Reference Collections &			**AMOUNTS DRAWN FROM FUNDS**		
Maintenance	99548.38		For Natural History Study	31173.35	
Library Books, Book Binding,			For Nature Conservation	163034.01	
Subscriptions & Contingencies	50923.85		For Other Educational Exps	31833.52	
Post Graduate Studies	12000.00		For Photography Contest &		
Photography Contest &			Exhibition Exps	8898.40	
Exhibition Exps	8898.40		For Gratuity Payment	616.00	
Rare Books Exhibition	10968.90	7560310.04	For Depreciation	312966.83	
			For Beautification Of		
			Dr.Salim Ali Chowk	15000.00	
Balance Of Surplus			For Contribution To Staff Trip	1450.00	564972.11
Carried Forward		3216.34			
Total Rs.		11903155.89	Total Rs.		11903155.89

BOMBAY NATURAL HISTORY SOCIETY

AS PER OUR REPORT OF EVEN DATE

Sd/-
J C DANIEL
HON. SECRETARY

Sd/-
C G WAKANKAR
HON. TREASURER

Sd/-
HABIB AND COMPANY
CHARTERED ACCOUNTANTS
BOMBAY

Bombay, Dated 9th January, 1993

BOMBAY NATURAL HISTORY SOCIETY

NATURE EDUCATION SCHEME

RECEIPT AND PAYMENT ACCOUNT FOR THE YEAR ENDED 31-3-1992

RECEIPTS	Rs.	PAYMENTS	RS.
To Balance As On 1-4-1991 In Current Account With ANZ Grindlays Bank p.l.c.	1200.99	By Amounts Due To BNHS As On 1-4-1991	92308.72
		By Salaries To Nature Education Organiser	55617.00
To Grant - Govt Of Maharashtra For The Year 1990-91	47910.00	By Contingency Expenses	3046.15
To Sale Of Nature Education Booklets	95.00	By Balance As On 31-3-1992 In Current Account With ANZ Grindlays Bank p.l.c.	1200.99
To Amounts Due To BNHS As on 31-3-1992	102966.87		
Total Rs.	152172.86	Total Rs.	152172.86

BOMBAY NATURAL HISTORY SOCIETY

AS PER OUR REPORT OF EVEN DATE

Sd/-
J C DANIEL
HON. SECRETARY

Sd/-
C G WAKANKAR
HON. TREASURER

Sd/-
HABIB AND COMPANY
CHARTERED ACCOUNTANTS
BOMBAY

Bombay, Dated 9th January, 1993

BOMBAY NATURAL HISTORY SOCIETY

Hornbill House, S. B. Singh Road, Bombay 400 023.

Minutes of the Annual General Meeting held on 14th September 1991

The Annual General Meeting (AGM) of the Society for the year 1990-91 was held at Hornbill House on 14th September 1991 at 5.00 p.m. The following members were present :

Ms Abdulrahman Beena, Mr Acharya Jayprakash B, Mr Akhtar S Asad, Mr Almeida M R, Mr Amladi M S, Ms Anthony Celene, Mr Balsara D C, Mr Bannerjee Deb Priya, Mr Behramfram M P, Dr Bhagwat A M, Dr Bhagwat Sanjay, Dr Bharucha Erach, Mr Bhatia P M, Mr Bhatia V R, Mr Bhatkal Suresh G, Mr Bhaumik S D, Prof. Bole P V, Mr Brahme Unmesh, Mr Bulsara Y N, Mr Burman Sanat, Mr Chandramohan S, Mr Chaturvedi N, Dr Chhapgar B F, Mr Daniel J C, Mr Dastur Kersi, Mr Deepak S, Mr Desai Narendra, Mrs Dev Joan M, Mr Devare Mihir, Mr Dighe R D, Ms D'Sa Doreen, Maj Gen E D'Souza (Retd), Mrs Elavia Khurshid P, Mr Elavia P T, Mr Fernandes Manuel, Mr Fernandes Peter, Mr Gandhi Sorab D N, Mr Gogate Ashutosh, Dr Grubh Robert, Mr Gulati R M, Mr Gupta Bharat, Mr Haritwal Vinod, Mr Hussain S A, Ms Iyengar Kartika, Mr Jacob Samuel, Mr Jamdar Nitin, Mr Karamchandani K P, Mrs Khambata V R, Mr Khamker Saleem S, Dr (Smt) Kirloskar M, Dr Kothari A S, Mr Mehta Bansi, Mr Andy Mendonca, Mr B Menezes, Dr Menon Shashi, Mr Mistry Hirji C, Mr Modi R M, Mr Monga Sunjoy, Mr Mulla N D, Mr Murthy S G, Dr Nanavati A N D, Mr Narayan Goutam, Prof. Pandya Parvish, Mr Paralkar Ulhas, Mr Parikh Niranjan O, Ms Patil Sobha, Ms Patrao Mona, Mr Phadnis R S, Mr Quader Suhel, Mr Rane Ulhas, Mr Ranjit Shashank, Mr Rego Rudi E, Mr Remedios T, Ms Rustomjee Katie, Mr Sahgal Bittu, M/s. Sanctuary Magazine, Mr Sapre S S, Ms Savla Manju, Mr Sethna J, Mr Sethna N D, Ms Shah Shridevi, Mr Shingre Vilas, Mr Shirke Arvind Kumar, Mr Shroff R K, Mr Soares Leo, Mr Srivastava Kiran, Mr Tarapore S F, Mr Vaidya Sureshchandra R, Mr Vajifdar K K, Ms Vajifdar Saber Kersasp, Mr Varadachary Ajay, Mrs Variava D S, Mr Vessaokar Eustace, Mr Wakankar C G.

The President, Prof. P V Bole, welcomed the members to the AGM. Before commencing the proceedings of the meeting, Prof. Bole mentioned about the sad demise of Mr Rajiv Gandhi, the Patron of the Society since 1985, and of Dr P R Deoras, Ex-member of the Ex.Committee. As a mark of respect to the memory of these two persons, all the members stood in silence for 2 minutes. The President requested the Honorary Secretary to convey the sad sentiments of the AGM to the members of the bereaved families.

Item 1 : Confirmation of minutes

The minutes of the AGM for 1989-90 held on 15th Sept. 1990 were confirmed, duly proposed by Mr Sohrab Gandhi and seconded by Mr J C Daniel.

Item 2 : Annual Report of the Committee for 1990-91

Presenting the Report of the Committee for the year ended 31st March 1991, Mr Ulhas Rane, Honorary Secretary, mentioned that the following corrections/omissions in the Report would be suitably incorporated :

i) Report of the Products Sub-Committee and the Journal would be incorporated, (ii) Mrs D S Variava continued to be. the Chairperson of SANCF Sub-Committee and therefore, the figures '31.12.90' appearing against her name on page 13 of the Report should be replaced by words 'onwards' and (iii) the name of Dr A N D Nanavati would be added above words 'Hon. Treasurer' on page 24.

Giving the salient features of the activities during the year, Mr Ulhas Rane mentioned a few deficiencies namely about a) the need to increase the rates of subscription for members because of financial implications, b) the delay in actual functioning of the SACON, c) the delay in commencement of the ODA Conservation Education Project, d) the ending of the Projects at Bharatpur and Point Calimere in June 1991 without further research programme, e) the resignation of Dr A R Rahmani, Senior Scientist and the need to improve the research atmosphere in the Society, f) the retirement of Mr J C Daniel, Director, in March 1991 and the delay in the appointment of his successor.

On the positive side, he mentioned about a) the improved active interaction with the Advisory Committee members, b) the bi-monthly circulars initiating interaction with outstation members, c) improved coordination with State and Central Governments and release of pending grants from the Government of Maharashtra, DOE and DST, d) the approval of Municipal Corporation of Greater Bombay to name the Traffic Island at the junction of K K Dubash Road and S B Singh Road as Dr Salim Ali Chowk, e) the acceptance of the Patronship of the Society by Shri R Venkataraman, President of India, f) the proposal to bring out a postage stamp in honour of late Dr Salim Ali, g) the State Govt.'s offer to give a piece of land near Nagpur for putting up a Research Centre and residential flats/plots for staff quarters in Bombay, h) the formulation of Employees' Service Rules and the Organisational Structure and revision of pay structure of the staff, i) the completion of the airconditioning work of the Collection Room and the Library, j) the bringing out of 'Hornbill' in a new format, k) the participation of staff in national and international events, and l) the successful organising of the Waterfowl Count with involvement of members and voluntary agencies.

The Honorary Secretary informed the AGM about the new ventures such as a) intensifying of the membership drive, b) proposals to bring out new products and publications, e.g. the cassettes on bird calls, revision of the Encyclopedia and Pictorial Guide of Birds, c) the exhibition of rare books, d) the organisation of Nature Education activities for the armed forces, teachers and for the underprivileged children in Bombay and rural areas and e) the setting up of a Research Centre at the Society's land at Goregaon.

The President invited comments from members on the Report. There was a discussion on the Report in which Dr B F Chhapgar, Mr K P Karamchandani, Mr P M Bhatia, Mr J C Daniel, Mr Goutam Narayan, Mr Chandrakant Wakankar, Mr Behramfram, Mr Sunjoy Monga, Mr Bharat Gupta, Mr Bittu Sahgal, Ms K Rustomji, Mr J Acharya, Mrs Joan D'Souza and Mr S Gandhi participated. Questions were asked about the University Studies Sub-Committee, market survey and pricing of new Hornbill and discontinuation of old series of articles, registration system for programmes, Nature Education activities involving children and teachers. The Hon.Secretary clarified various points. To a query from Mr Karamchandani, Mr Bittu Sahgal explained that he resigned from the post of Hon.Treasurer as he did not agree with some of the management and financial decisions taken by the Committee.

The Annual Report was thereafter approved, duly proposed by Mr Bharat Gupta and seconded by Mr P M Bhatia.

Item 3 : Balance Sheet and Statement of Accounts for 1990-1991

The Honorary Treasurer, Dr A N D Nanavati explained the main features of the Statement of Accounts. Mr P M Bhatia enquired about the need to keep huge balances in current account with banks (pg 41) and the nature of unspent grants at Rs. 51,88,498 (pg 30). The Dy. Director (Accounts) and the Hon. Secretary clarified the points. Mr J C Daniel pointed out that the balance shown under 'Other liabilities-SACON' on page 31 of the Report was not really needed for SACON as they have already received the Govt. grants. He suggested that this could be used as seed money to put up the Research Centre at Goregaon land.

The Accounts were thereafter approved, duly proposed by Mr P M Bhatia and seconded by Mr Niranjan Parikh. The members expressed their appreciation for the efforts of the Accounts Department for timely completion of the audit.

Item 4 : Appointment of Auditors

The members agreed that M/s. Habib and Co., Chartered Accountants, be reappointed as Auditors of the Society for the year 1st April 1991 to 31st March 1992, on the same remuneration as the last year i.e. Rs.2,000/-. This was proposed by Mr Jayaprakash Acharya and seconded by Dr A M Bhagwat.

The members expressed their appreciation for the cordial cooperation extended to the Society by M/s. Habib & Co.

Item 5 :Rules and Regulations - Amendments

The amendments circulated with the notice of AGM were discussed and further amendments proposed by Mr J C Daniel and Mr Debi Goenka were also considered. The amendments proposed by the Committee evoked a keen discussion in which Messrs Chandrakant Wakankar, N D Mulla, Behramfram, Niranjan Parikh, S Gandhi, Jayaprakash Acharya, Nitin Jamdar, J C Daniel, Humayun Abdulali, Dr A N D Nanavati, Mrs D S Variava, Mrs V Khambatta, Dr B F Chhapgar and Dr Shashi Menon participated. The following decisions were taken :

Item i - Minor Changes : The amendments proposed were approved.

Item ii - Emeritus Status : The new Rule to be placed after Rule 14 on 'Emeritus Status' was approved with the correction that it should be by an unanimous vote of all members of the Committee. This correction was suggested by Ms Katie Rustomjee and approved unanimously. The members desired that for want of time the remaining amendment may be considered at an adjourned meeting of AGM.

Item 6 : Election to the Executive Committee for 1992-93

The President informed the meeting that 13 valid nominations have been received for election to the Executive Committee for the Calendar years 1992 and 1993 as follows :

1. Mr M R Almeida
2. Dr E K Bharucha
3. Mr Unmesh Brahme
4. Dr B F Chhapgar
5. Mr J C Daniel
6. Dr (Ms) Meena Haribal
7. Dr Ashok S Kothari
8. Dr Shashi Menon
9. Mr Sunjoy Monga
10. Prof. Parvish Pandya
11. Mr Shreekant Pol
12. Mr T V Sowrirajan
13. Mr Chandrakant C Wakankar

Two nominations received after the last date and not duly proposed or seconded had been considered invalid. The President added that since there was 13 nominations as against 12 vacancies, it would be necessary to conduct an election. One of the senior members, Mr M R Almeida offered to withdraw his nomination at the AGM to avoid expenses of election. This was not accepted as there was no provision in the Rules. Further, there was a suggestion to invite fresh nominations which also could not be accepted as there was no provision in the Rules.

Item 7 :

The Honorary Secretary thanked the staff of BNHS for their continued assistance and cooperation in carrying out the functions of the Society during the year. As a token of gesture, a senior staff member, Mr Bapu Jadhav, was honoured for his long and dedicated services to the Society.

The meeting ended with a vote of thanks to the Chair.

BOMBAY NATURAL HISTORY SOCIETY

Hornbill House, S. B. Singh Road, Bombay 400 023.

Minutes of the adjourned Annual General Meeting held on 11th November 1991.

An adjourned Annual General Meeting of the Society was held on 11th November 1991 at Hornbill House at 6 PM. The folllowing members were present :

Prof. P V Bole, President (In the Chair)

Ms Hira U Punjabi
Mr S M Ketkar
Mr Unmesh Brahme
Mr M S Behramfram
Mr. D D Mehra
Mr T V Sowrirajan
Mr Suhas Gaonkar
Mr Ashutosh Gogte
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Mr Bansi Mehta
Mr M I Fernandes
Mr Vinod Haritwal

The meeting discussed the amendments proposed to the Rules and Regulations of the Society as circulated with Honorary Secretary's letter no 4371/91 dated 11th October 1991, in which M/s J R Acharya, M R Almeida, Celine Anthony, M S Behramfram, Unmesh Brahme, Dr B F Chhapgar, J C Daniel, Debi Goenka, Nitin Jamdar, K P Karamchandani, D D Mehra, Rishad Naoroji, Bansi Mehta, Parvish Pandya, A G Puranik, Bittu Sahgal, T V Sowriajan, Kiran Srivastava and Chandrakant Wakankar participated. The decisions taken on the amendments were as follows :

Rule No. (1)	Amendment to Rule in brief (2)	Resolution passed on the Rule (3)
7	Life Family Membership	Mr J C Daniel mentioned that there was no need for this Rule. This was unanimously accepted.
22	4 weeks notice to members instead of the present 14 days for convening the AGM	The Resolution as proposed by Mr N D Mulla was approved unanimously. The EGM resolved that a fresh call for nominations for election to the EC be issued with a reply period as per the new Rule, while the validity of all nominations already lawfully received is manintained. When put to vote, 24 voted for the resolution and 14 against.
26	Delete the words "at least 10 ... of the Society" and substitute the words "at least 1% of the total membership at that particular time".	As against the Executive Committee's proposal, Mr N D Mulla suggested a requisition by at least 25 members and Mr Debi Goenka suggested the retention of status quo, i.e. 10 members. The resolution was put to vote. The voting was 15 in favour of 25 numbers, 3 in favour of 1% of total membership and 2 in favour of 10 numbers. Accordingly, a requisition by 25 members was approved.
28	i) The term of EC to be 3 yrs.	The amendment was put to vote. The voting was as under : 10 members in favour of the amendment and 16 against it. Accordingly, the resolution was defeated and the present term of 2 year period was approved.

<table>
<tr><th>Rule No.
(1)</th><th>Amendment to Rule in brief
(2)</th><th>Resolution passed on the Rule
(3)</th></tr>
<tr><td></td><td>ii) 2 members to be nominated by the 4 ex - officio members and 10 elected members</td><td>Nomination of members : The amendment in slightly different combinations was put to vote and the voting was as follows :
<table>
<tr><th>Amendment proposed</th><th>Proposed by</th><th>No. of votes</th></tr>
<tr><td>a) 10 elected and 2 nominated</td><td>EC</td><td>3</td></tr>
<tr><td>b) 12 elected as at present</td><td>Dr A M Joshi</td><td>11</td></tr>
<tr><td>c) 12 elected and 2 nominated</td><td>Mr Rishad Naoroji</td><td>24</td></tr>
</table>
Thus, the Rule to provide for 12 elected members and 2 nominated members was adopted.</td></tr>
<tr><td>29</td><td>For the words "seven days prior to the date of the meeting", substitute the words "two days prior to the date of the meeting".</td><td>The amendment was unanimously passed duly proposed by Mr. N D Mull and seconded by Mr Hirji Mistry</td></tr>
<tr><td>47</td><td>Word "Benefactors" to be deleted.</td><td>The members unanimously agreed to the proposal made by the Committee.</td></tr>
</table>

Other Business :

Mr Ulhas Rane informed the meeting that the Society has been paying to the Auditors (in addition to the sum of Rs 2,000/- paid for auditing the Society's account), a sum of Rs 2,000/- for auditing each of the Project accounts and the approval of the AGM had not been obtained for the latter payments. He now requested the AGM to approve the payment of fees for Projects also. The AGM resolved that there seemed to be no objection for paying the Auditors' fees as hitherto and that specific concurrence of the AGM was not necessary.

The meeting ended with a vote of thanks to the Chair.

BOMBAY NATURAL HISTORY SOCIETY

Hornbill House, S. B. Singh Road, Bombay 400 023.

Proposed amendments to Rules and Regulations of the Bombay Natural History Society.

The Society's Rules and Regulations do not provide for taking action against any member of the Executive Committee who absents himself/herself without assinging reasons from three consecutive meetings of the Committee.

For the Extraordinary General Meeting there is no provision for quorum. This is proposed to be kept at the same level as for the Annual General Meetings.

The proposed amendments will, therefore, be as under :

Rule No.	Amendments to Rule
New Rule after Rule 31	**Absence from Committee meetings :** Any member absenting himself/herself without assigning reasons from three consecutive meetings of the Committee shall be deemed to have vacated his/her seat on the Committee. In such cases, the Committee shall fill the vacancy by coopting any other eligible member.
Addition to Rule 26	**Extraordinary General Meeting (EGM):** The quorum for EGM convened either at the initiative of the Committee or upon the requisition of members shall be the same as prescribed under Rule 24 for Annual General Meetings.

THE SOCIETY'S PUBLICATIONS

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BEHAVIOUR PATTERNS OF THE BLACKBUCK *ANTILOPE CERVICAPRA* UNDER SUBOPTIMAL HABITAT CONDITIONS[1]

ERACH BHARUCHA AND KIRAN ASHER[2]

(*With two text -figures*)

Key words : *Antilope cervicapra,* behavioural ecology, conflict issues

The occurrence of fragmented and localised hyperdense populations of *Antilope cervicapra* is a relatively recent phenomenon in India. This has been induced following the notification of small protected Areas and the institution of schemes such as Drought Prone Area Projects that offer this species some degree of protection. However, in such areas the limited quantum of fodder leads to local intensification of people - wildlife conflict, due to unacceptably high levels of crop damage. In these locations, sub - optimal habitat conditions have led to changes in habitat utilisation, feeding behaviour, movement patterns as well as modifications in the herd size and structure of the blackbuck. This could be related to either a particular herd - size and structural configuration being partial to a specific habitat sub - type or due to sub - optimal habitat conditions inducing a change in herd - size and structure. Careful management based on habitat analysis and related blackbuck behaviour can help to re-define management strategies towards mitigating conflict. The study focuses attention on Rehekuri Blackbuck Sanctuary in Karjat Taluka of Maharashtra, which typifies the situation encountered in several other semi-arid areas in India.

INTRODUCTION

The population of *Antilope cervicapra* appears to have increased in some areas of India during the last decade or two. This highly localized increase is related to the notification of sanctuaries as well as the establishment of Drought Prone Area Projects (DPAP). Thus some observers have indicated that the species is not under any further threat (Rahmani 1991). This is not necessarily true as the present total population is nowhere close to the number that existed in the great herds of the past decades (Jerdon 1874).

In Protected Areas (PAs) where blackbuck populations show an upward trend they become increasingly dependent on adjacent croplands, leading to increasing man-animal conflict due to localised intense crop damage. However quantified information on crop damage is lacking for most areas. In the past a large number of farmers were affected by crop damage due to blackbuck. However as the animals could spread over large areas the amount of damage to the individual farmer was small and was thus accepted as inevitable. Today the protected pockets that have an unduly high population density of blackbuck provide a milieu for excessive localised crop damage for those farmers who live in the immediate vicinity of these sanctuaries and DPAP plantations.

Micro level habitat use by blackbuck has not been studied and it is essential to collect data on several aspects of their behaviour and ecology to manage their habitat appropriately. A brief survey of blackbuck habitats in Rajasthan, Madhya Pradesh, Gujarat, Maharashtra, Karnataka and Tamil Nadu showed that the problem due to localized high densities has a fairly consistent pattern. This paper addresses itself to solving conservation problems in Rehekuri Blackbuck Sanctuary which is an example of animals living in suboptimal conditions leading to behavioural changes and in which localized overabundance causes man-animal conflict.

---

[1] Accepted February 1993.

[2] Saken, Valentina Society, North Main Road, Koregaon Park, Pune 411 001.

OBJECTIVES

The primary goal of this study was to provide information to help evolve an ecologically sound management plan for Rehekuri so that it can be used as a basis for the management of other similar problem areas. The broad aim of the study was to provide guidelines for the management of the area within and outside the sanctuary limits with special reference to man-animal conflict.

The objectives were to:

I. Study the present habitat conditions and utilization pattern by the blackbuck:

a) To describe geographical, climatological and land use patterns of the study area.

b) To document seasonal variations.

c) To provide a historical perspective of the changes in the area in relation to the habitat of the blackbuck.

d) To identify ecologically based zones in the habitat utilized by blackbuck.

e) To record land use in the surrounding area, quality and quantity of vegetation cover, and availability of water.

II. Study the behavioural patterns of blackbuck in relation to variations in habitat conditions:

a) To study the population density, herd size & structure and its relationship to the mosaic of habitat types in the area.

b) To document feeding behaviour and identify food preferences including browsing and dependence on crops.

c) To study interactions between local people and blackbuck.

METHODS

Regular observations were made at Rehekuri from July 1986 to June 1987, so that all the seasonal changes were covered. On an average a two-day visit was made every fortnight. From June 1987 onwards visits were made once every 5 or 6 months up to June 1992. Sightings of blackbuck herds were recorded while following a standard circuit that adequately covered various ecologically different areas of the sanctuary. Each ecologically distinct plot was transected in proportion to its size while walking at a steady pace. Thus the transect length and time spent in each plot was related to plot size providing an adequate representation of habitat use. All the blackbuck noted within a strip of about 100 metres on either side of the circuit were recorded. Occasionally, blackbuck were flushed if hidden in a particular thicket. It can be argued that a correction factor should be used to equate the number of sightings in open grassland, with those in plantations. However, this was not necessary as the lightly wooded area is a flat open plantation of small trees which are in relatively straight rows with minimal undergrowth that does not hide the animals within hundred metres. Thus, as the observer walked along the circuit a good view of the plantation area was obtained.

One hundred sightings of herds were made following the same circuit as described above. This was done in different seasons during the course of one year. Careful note was made of the activity of the animals, the structure of the herd, the number of animals per herd, the location of the sighting and any habitat factor affecting their behaviour during each circuit. Movements of the herds were also recorded. The number of animals sighted is not to be confused with the total population at Rehekuri, as only a part of the population was recorded during a circuit. Although we have analyzed the observations made of a hundred herds, many sightings were made while not on an observation circuit. These have not been used for this analysis. However they helped corroborate the observations made during the circuits.

The sanctuary and adjacent farmland used most frequently by blackbuck was zoned ecologically and the plots measured on the map by a digitizer. Photographic documentation of the animals and the condition of the habitat was made throughout the study. An aerial survey of the area was conducted in March 1987. A census was conducted in December 1986 with the help of the students of St. Xavier's College, Bombay and the Forest Department staff.

DISCUSSION

1.1 - The Study Area : Rehekuri Blackbuck Sanctuary lies in the Karjat taluka of Ahmednagar district in Maharashtra in the rain shadow region of the Western Ghats. The area is used for marginal cultivation and the wasteland is overgrazed by sheep and cattle. The erstwhile natural habitat was a typical example of the 'Southern Tropical Thorn Forest' where grassland and scrub were interspersed with open thorn woodland characterised by *Acacia* spp. reaching a height of 6 to 9 metres. This is now highly modified. In the early 1960s the Forest Department established a plantation of *Eucalyptus* spp., *Dalbergia sissoo* and *Azadirachta indica* under the Drought Prone Area Project Scheme. Certain species of grass were also introduced in the more recent years. Rehekuri was notified as a sanctuary in this DPAP plot in 1980 as several blackbuck began to frequent the area. Between 1960 and 1980 the population of blackbuck grew from about 20 animals to around 200. The sharp rise in population soon after protection can be attributed mainly to an aggregation of blackbuck from surrounding unprotected areas. A large proportion of the area used by the blackbuck is outside the sanctuary and is under cultivation. 'Jowar' (*Sorghum vulgare*) is the major crop. Pulses including 'tur'(*Cajanus cajan*), 'gram'(*Cicer arietinum*), and the local 'julega' are sown as mixed crops. Some sunflower (*Helianthus annuus*), 'bajra'(*Penni setum typhoides*) and sugarcane (*Saccharum officinarum*) is also cultivated. Due to the poor, 'murram' and rocky soil condition, and lack of water, some areas are barren or are frequently fallow. The climate is essentially arid and the area suffers from repeated drought. The mean annual temperature is 25 °C, with a maximum of 40 °C in midsummer (May), and a minimum of 8 °C in mid-winter (December). The vegetation, especially the grass cover varies seasonally, being green for only two or three months in a year during the rainy season. The situation is further aggravated during drought years when the grass growth is poor and dries up even earlier. Karjat taluka was one of the severely affected areas in the drought that hit this part of Maharashtra during the period 1985 to 1987.

Figure 1 shows the habitat subtypes in different plots.

1.2 (a) The Habitat Conditions within and outside the Sanctuary:

A large proportion of the sanctuary area is covered by a plantation. The trees used for afforesting the area consist of 44.3% *Acacia* spp., 17.7% *Azadirachta indica,* 29% *Dalbergia* spp., 9% *Eucalyptus* spp. a few Sandalwood trees, and some *Ziziphus* bushes. However there is one patch of open grassland with a few *Acacia* trees still left in the sanctuary which is reminiscent of the blackbuck's natural habitat. There is a percolation tank at one end of the sanctuary. Water is also pumped to an artificial water hole within the sanctuary. However the area faces a severe water shortage in summer. The surrounding area which is also utilized by this population of blackbuck consists of agricultural

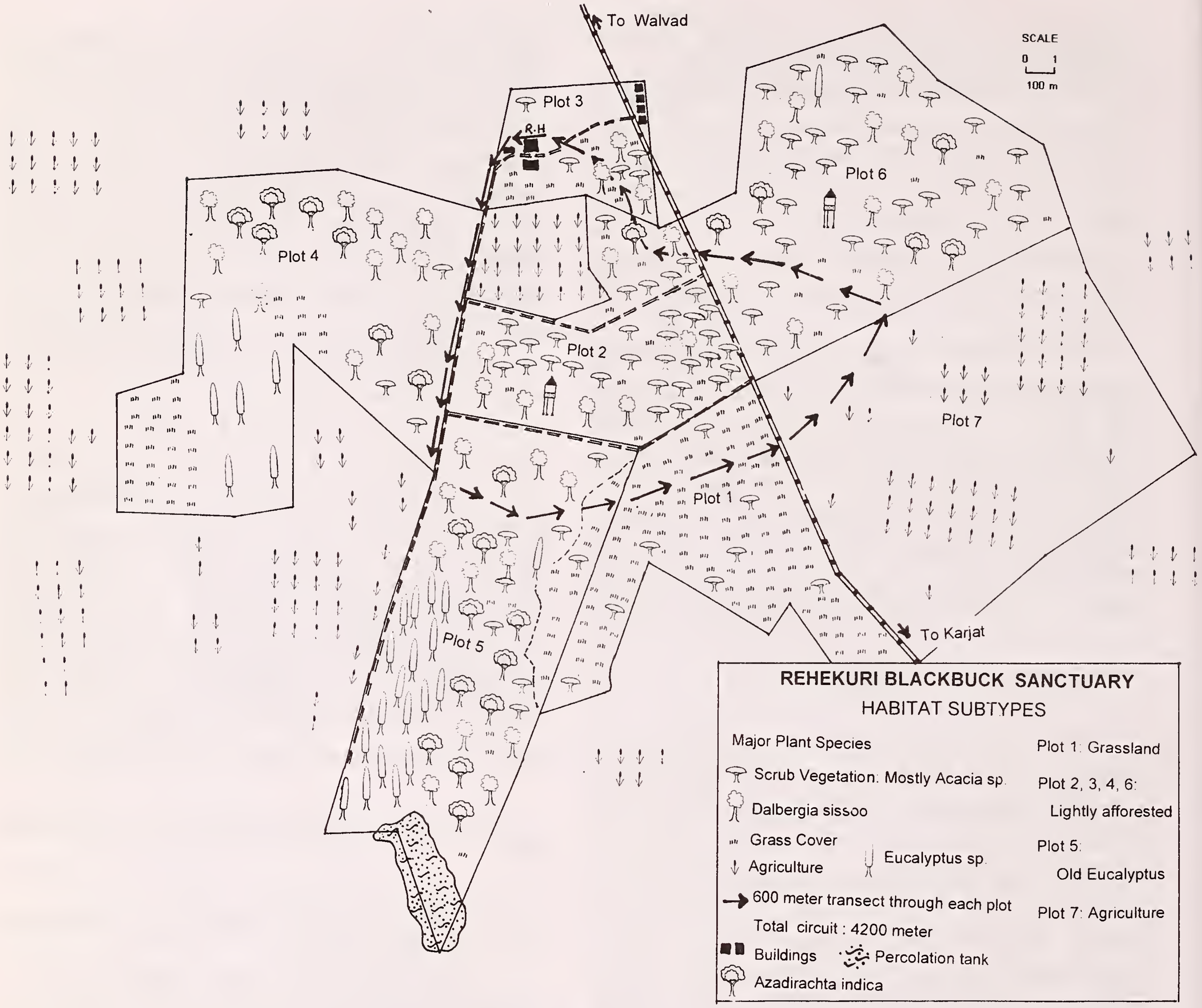
To Walvad
SCALE
0 1
100 m
Plot 3
R.H
Plot 6
Plot 4
Plot 2
Plot 7
Plot 1
Plot 5
To Karjat
REHEKURI BLACKBUCK SANCTUARY
HABITAT SUBTYPES
Major Plant Species
Scrub Vegetation: Mostly Acacia sp.
Dalbergia sissoo
Grass Cover
Agriculture
Eucalyptus sp.
600 meter transect through each plot
Total circuit : 4200 meter
Buildings
Percolation tank
Azadirachta indica
Plot 1: Grassland
Plot 2, 3, 4, 6: Lightly afforested
Plot 5: Old Eucalyptus
Plot 7: Agriculture

Fig. 1. The habitat subtypes in different plots.

land. After harvest these areas of fallow agricultural land outside the sanctuary continue to be frequented by the animals that feed on the stubble and residual weeds.

The sanctuary which covers only 2.17 sq.km. has an irregular periphery (Fig. 1). Thus, animal movements from one area to another frequently involve transgressing the surrounding farmlands. An agricultural area is present within the Protected Area (Fig. 1).

Habitat Subtypes: The area can be divided into four ecologically diverse habitat subtypes:

A - The grassland, with a few relict trees and bushes;

B - The thinly afforested area interspersed with grass;

C - The old plantation area; and

D - The agricultural area which has seasonal crops, or forms fallow land.

TABLE 1

PERCENTAGE OF AREA IN EACH HABITAT SUBTYPE

Plot no.	Habitat subtype	Area sq.km	Percentage
1.	A	0.375	9.92
2.	B-(1)	0.446	11.79
3.	B-(2)	0.142	3.75
4.	B -(3)	0.679	17.96
5.	C	0.649	17.16
6.	B- (4)	0.638	16.88
7.	D	0.851	22.51

The area in habitat subtype B is 42.7%

Note: The total area (3.78 Sq. km) is greater than the size of the sanctuary (2.17 sq.km) as the study area includes the agricultural land in its immediate vicinity.

These four habitat subtypes are represented in seven adjacent plots (Fig. 1), Table 1.

Plot 1 -The typical grassland savannah habitat: Type A.

Plot 2 - The central area of the sanctuary which consists of thinly afforested plantation: Type B - (1).

Plot 3 - The area around the Forest Guest House and including the Forest Department staff quarters, which is thinly afforested but is highly disturbed: Type B - (2).

Plot 4 - A thinly afforested area which had a corral where the blackbuck were stall-fed during the early part of the study: Type B - (3).

Plot 5 - A heavily afforested area consisting of the older *Eucalyptus* plantations and relatively heavy undergrowth especially along the water course which flows towards the percolation tank. Until 1989 there was a Forest Department nursery on the edge of the water body with considerable disturbance: Type C.

Plot 6 - This is a thinly afforested area similar to plot 2 but situated across the Karjat road:Type B-(4).

Plot 7 - This plot consists of agricultural land which is generally partly cultivated. In patches it resembles degraded grassland and is devoid of trees. Due to its open nature it appears similar to plot 1 in summer. (Type D).

The area around the sanctuary is primarily agricultural and is similar to plot 7 : Type D.

1.2 (b) - Seasonal Variations: The major seasonal variation consists of changes in the grass cover on which the blackbuck graze (Table 2). The favoured forbs found here such as *Indigofera* are preferred to the grasses and are rapidly grazed. Some grasses and forbs which were found to flower briefly in July - August were *Aristida. Tribulus terrestris, Justicia diffusa, Tricolepsis glaberrima, Alysicarpus tetragonolobus, Desmodium triflorium, Heliotropium marifolium, Melanocenchrus jaquemontii, Tephrosia tenuis, Leucas linifolia, Mansonia senegalensis* and *Cyanotis fasciculata.* As the grasses are overgrazed during drought conditions by an invasion of cattle and goats, the ground cover deteriorates considerably leaving patches of the less favoured, unpalatable *Aristida* sp. of grass. When most of the grass in the open area

TABLE 2

SEASONAL CHANGES IN GRASS AND CROP AVAILABILITY

Month	Condition of grass	Crop availability							
		Jowar	Bajra	Moong	Tur	Gram	GNut	Veg	Sug
June	3-6		P	P	P		P		G
July	6		G	G	G		G	P	PG
August	6		G	G	G		G	G	PG
September	5	P	H	G	G		G	G	PG
October	5	G		H	G	P	G	H	PG
November	4	G			G	PG	G		PGH
December	4	G			H	G	GH	P	PGH
January	3	G			H	G	H	G	PGH
February	2	H				H		G	PGH
March	2							G	GH
April	2							H	GH
May	1								G

Key	Grass Quantity	Colour	Key	Crop
6	good	green	P	Planted
5	good	yellow	G	Growing
4	fair	Yellow-brown	H	Harvested
3	poor	Yellow-brown		
2	Very poor	Yellow-brown		
1	extremely poor	brown		

(Note: Subject to changes according to monsoon / drought conditions.)

dries up, small islands of yellow-green grass persist only around the base of each tree in the plantation. The most commonly browsed species of trees are *Ziziphus* and *Acacia*. These are increasingly utilized by blackbuck after the grasses have been grazed away. During the drought when food was scarce the blackbuck turned to chewing on *Agave* leaves, destroying several fences in the process.

Seasonal changes in the crop patterns also affect the movement and dispersal of the blackbuck outside the sanctuary. The 'jowar' crop is damaged since the grass cover deteriorates during this period. The blackbuck thus tend to move out of the sanctuary to feed on the crops. Sunflower plants are not damaged by the blackbuck. However, there are unconfirmed reports of blackbuck eating the flower itself. All other crops were damaged. The extent is highly variable and is related to the distance from the sanctuary and the extent of crop protection.

2.0 - Habits and Behaviour: The data on population density, herd strength and structure at Rehekuri is compiled from one hundred sightings made during the course of the year (July 1986 to July 1987).(Fig. 2)

2.1 - Population Density: The blackbuck population mainly uses an area of about 4 sq.km. On occasion blackbuck are also seen further away. The total number of animals in the sanctuary shows fluctuations from time to time. A total count which was carried out in December 1986 in Rehekuri sanctuary and in the farmland around it showed that there were 250 animals. Thus an estimated 250 animals frequent about 4 sq. kilometres. This gives a population density of 1 per 1.6 ha. However, Forest Department census done previously, estimated that there were as many as 400 animals in the sanctuary area, i.e. about 1 blackbuck per ha.

Thus, there are between 250 to 400 animals using 400 ha. of sanctuary and adjacent farmland. Even if the lower figure of about 250 in 4 sq.km is considered, this aggregation constitutes a very high population density. Comparative figures on population of blackbuck from Velavadar (Rashid 1977) and Pt. Calimere (Daniel 1967) are appreciably lower than at Rehekuri. Available data from other areas (Nair 1976, Natrajan *et al.* 1978) show that census figures have wide variations. As these authors have used different census techniques their results show a considerable difference in the counts obtained for the same area. This is supported by the findings of Rahmani (1991). This could account for the variation in counts made during the study period and counts made by the Forest Department at Rehekuri.

2.2 - Habitat Preference: An analysis of the 100 herd sightings in different plots is shown in Table 3. This shows that the most frequently used area was plot 1, followed by plots 2,4,6,3,7, and 5 respectively.

Plot 1 is open Savanna-like grassland which resembles the ecosystem that once constituted the blackbuck's favoured habitat. This is the most frequented area in the sanctuary. Plots 2 and 4 have large open strips of grass amidst the plantation which has a low canopy cover and is thus frequently used. Plots 3 and 6 are similar to 2 and 4 but are disturbed due to the Forest Department quarters and the Forest Bungalow. Plot 7 though open wasteland, is 'malki' land, and is very close to well guarded seasonal crops. Blackbuck move through this area to go into Plot 6 if they are disturbed by tourists in the sanctuary. They also graze on stubble after crops are harvested. The least used area is Plot 5 in which there was only one sighting. This has tall old Eucalyptus trees and is full of gullies and eroded

TABLE 3

NUMBER OF HERD SIGHTINGS IN DIFFERENT PLOTS

Habitat subtype	A	B	B	B	C	B	D	Total Sightings
Plot	1	2	3	4	5	6	7	
Number of herds sighted	42	34	4	12	1	5	2	100

TABLE 4

PERCENTAGE OF HERD SIGHTINGS IN DIFFERENT HABITAT SUBTYPES IN RELATION TO PERCENTAGE OF TOTAL AREA

Habitat subtype	% of total area	No. of total sightings
A	9.92	42
B	50.38	55
C	17.16	1
D	22.52	2
A (Unmodified Habitat)	9.92	42
B+C+D+ (Modified habitat)	90.06	58

murrum. It is thus an unfavourable area where the animals are rarely seen. The area in habitat type D consists of only the agricultural plots immediately adjacent to the sanctuary. However, the animals disperse outside this area to feed in similar croplands. This habitat is used sporadically for a variable distance from the sanctuary. Since the more peripherally situated crops are visited infrequently these have not been taken into account in this study.

Table 4 demonstrates that although habitat subtype A (open grassland) constitutes only about 10% of the area, 42% of sightings were recorded here. In contrast, in habitat subtype B (thinly afforested plots), which consists of 50% of the area there were 55 % of the sightings. Although the area of habitat subtype B is 5 times larger than that of the open grassland (Subtype A) the number of sightings in subtype B are not appreciably higher than in A. Only 1% of sightings were made in habitat subtype C (Which consists of the heavily wooded old plantation) but accounts for 14.2% of the total area. Only 2% of the sightings were made in habitat subtype D (Croplands) constituting 18.5% of the area. However it is possible that blackbuck utilize these croplands immediately adjacent to the sanctuary more frequently after dark when there are crops or residue to feed on. In the 9.9% area constituting the unmodified grassland habitat in the area there were 42 sightings, i.e. 4.24 sightings per unit area [(1 x 42)/9.9]. In the modified 90.1 % of the area, there were 58 sightings, i.e. 0.64 sightings per unit area [(1 x 58) /90.1]. Thus the ratio of sightings per unit area in modified: unmodified habitat is 0.64 : 4.24, i.e. 1 : 6.6. It can be deduced that the animals utilize the unmodified area 6 times more frequently than the modified area.

Several factors affect habitat suitability of different plots and produce a combination effect which is related to the number of sightings. Some of the important positive factors are availability of grazing and browsing, access to water, and cover in the afforested plots. A combination of factors is also responsible for the marked preference for plot A. The natural open grassland with scattered acacia trees provides grazing and browsing. It also provides good visibility so that humans can be sighted from a distance. Negative factors of the suboptimal habitat include the overgrowth of scrub and thick tree canopy, excessive and constant disturbance due to human movements of residential staff, tourists, and local inhabitants and the proximity to protected croplands during the growing seasons from where the farmers have to drive off the animals.

2.3 - Herd Size : At Rehekuri, the size of blackbuck herds varies from 2 to 200 animals (see Appendix A). Large aggregations occur when the area is disturbed by a sudden influx of several tourists within the sanctuary. These very large groups of over 100 animals which were seen occasionally during the study were temporary aggregations of smaller herds. Observations during such periods of obvious disturbance have been excluded. During 1986-87, groups of over 50 animals were seen on regular observation circuits in only 6 instances.

In a hundred herds sighted during the observation circuits the total number of animals counted was 2121. Thus the average herd size is 21 (see Appendix A). Groups of less than 20 animals have been designated as small herds and 21 or more as large herds. There were 51 sightings of small herds and 36 sightings of large herds (Table 7).

Blackbuck herds are known to be relatively open societies where individual animals join or leave the herd from time to time. The herd size and structure is in a constant state of flux. Available literature suggests that in an ungulate species there is a close relationship between their size and weight, their herd structure and their favoured habitat. Jarman (1974) has shown that small light ungulates that live in forests, are selective browsers, have a small group size, their reproductive unit is a pair and their anti-predator activity consists of hiding. In contrast large heavy ungulates favour grasslands, are nonselective grazers, have a large group size, with a male dominated harem and mass defense. Thus, 5 different groups of animals have been identified. The group size varies as follows: group I) 1 or 2 animals; II) 2 to 12 ; III) 12 to 100 : IV) upto 150; & V) upto 1000. The corresponding reproductive units in the groups are: I) A pair; II) Male with harem; III) Males, territorial in breeding season; IV) Defense of females in herds; & V) Male dominant hierarchy in the herd. Jarman (1974) thus suggests that each species has an in built mechanism to live in a certain group size and favours a specific habitat (Table 5).

Table 5

RELATIONSHIP BETWEEN BEHAVIOUR AND HABITAT SUITABILITY IN DIFFERENT UNGULATE SPECIES

Body weight	Light	Heavy
Habitat	Forest	Grassland
Diet	Selective browser	Unselected grazing
Group size	Pair	Male dominated herd
Antipredator activity	Hide	Mass defense

(TABLE ADAPTED FROM BEHAVIORAL ECOLOGY, JARMAN 1974).

According to the above grouping system, the blackbuck herd size fits into either group-group II or group III. In group II there should be 2 to 12 animals where there is a male with some form of a 'harem'. In group III there should be 2 to 100 animals with males showing territoriality. Blackbuck do not form a true harem since the herd composition changes constantly.

This study shows that modifications or

Table 6

DISTRIBUTION OF SIGHTINGS OF SMALL AND LARGE HERDS IN DIFFERENT PLOTS

Plot No.	Habitat subtype	Small herds (< 20)	Large herds (>20)	Lone male	Total of herds
1	A	16	21	5	42
2	B	20	11	3	34
3	B	2	1	1	4
4	B	7	1	4	12
5	C	1	0	0	1
6	B	4	1	0	5
7	D	1	1	0	2
Sub-total of 2 to 7		35	15	8	58
Total		51	36	13	100

variations in the habitat can influence herd size and structure of ungulates. It suggests that herd size in an ungulate may depend not only on the size and weight of a species and its intrinsic behavioural patterns but is related to temporal changes in environmental factors and spatial variations in its habitat.

The relationship between habitat subtypes and blackbuck herd size is shown in Table 6. Smaller herds were found more frequently under tree cover, whereas larger herds were seen more often in the open Savanna - like areas in Plot 1. Large herds were also recorded in open wastelands when the animals were sighted several kilometres from the sanctuary.

Where a variety of habitats from open to thickly wooded areas are present in the same area, a large variation in blackbuck herd size might occur. Smaller herds prefer covered areas where they can hide from predators. The larger herds show a preference for open areas where mass defence acts as an anti-predator mechanism. In the larger herd, the possibility of spotting a predator by one of the animals when it raises it's head during grazing is higher than in a smaller herd. Smaller herds in woodland may also develop more selective feeding habits and change from grazers to browsers.

Historically, large herds of blackbuck that were recorded in India were found in open plains (Dharmakumarsinhji 1978, Mungall *et al.* 1981, Neginhal 1980). Our observations indicate that the usual herd size in Rajasthan at Guda and Dhawa in open country were relatively larger in size than in Point Calimere in scrubland. At Kanha in Madhya Pradesh the grassy 'maidans' surrounded by forests had very small herds, however, the total number here is too small to draw any definite conclusion.

An important ecological variable is demonstrated by contrasting the frequency of habitat utilization of the most natural category which is Plot 1 (the savanna - like area), with all the other plots which are highly man - modified, (such as afforested plantation areas, croplands, and those that support human habitation), i.e. Plot 2 to 7. Thus, a near natural plot consisting of 9.9% of the area is compared with the highly man-modified plots constituting 90% of the area.

TABLE 7
NUMBER OF SIGHTINGS OF SMALL / LARGE HERDS IN PLOT 1 COMPARED TO OTHER PLOTS

Plot No.	Number of Small herds	Number of Large herds	Total No. of herds
1 (Savanna - like area)	16	21	37
2-7 (Plantation & agricultural area)	35	15	50
Total	51	36	87

Chi - Square calculated = 6.28 with 1 degree of freedom. Significant at 5%.

In Plot 1 out of 37 sightings, 16, i.e. 43.3% were of small herds, while 21, i.e. 56.7% were of large herds. In plots 2 to 7, out of 50 sightings, 35, i.e. 70% were of small herds, while 15, i.e. 30% were of large herds (Table 7).

Of the 51 sightings of small herds, 16 were in Plot 1, i.e.31.3%, while 35 were in Plots 2-7, i.e. 68.6%. In the 36 sightings of large herds, 21 were in Plot 1, i.e. 58.3%, while 15 were in Plots 2 to 7, i.e. 41.6%.

Mungall *et al.* (1981) found that Velavadar represents the open plain habitat type where there were herds of upto a thousand animals and that the Pt. Calimere herds were much smaller and were scattered through the brush, "moving across India from northwest to southeast, the observer changes perspective as to what a large herd is. One thinks of tens or hundreds instead of thousands". This may be related to changes in habitat characteristics from the more open to the more scrubcovered tracts in the south.

Nair (1976) showed that at Pt. Calimere herd size varies from 2 to 120 with a mean of 23. However Daniel (1967) for the same area claimed that the herd size is from 3 to 47, the normal being about 12. Ranjitsinh (1982) suggests that as populations increase and reach a certain size they split up and that this point is reached between 40 and 60 animals. Thus an increase in size leads to the formation of more herds.

Herd size is a flexible arrangement that can vary from place to place. Rehekuri shows a variable pattern and demonstrates how the population grouping may also be affected by human induced changes in the habitat.

2.4 - Herd Structure: A review of literature on ungulates (Bhattacharya and Chattopadhyay 1979, Daniel 1967, Dharmakumarsinhji 1978, Krebs and Davies 1981, Mungall *et al.* 1981, Ranjitsinh 1982) shows that different authors use different terms to describe the types of herds that are formed by blackbuck. Terms such as pseudoharem, quasiharem, breeding harem, male dominated herd, bachelor herd, female herd etc. have been often loosely used,

TABLE 8

NUMBER OF SIGHTINGS OF HERDS OF DIFFERENT STRUCTURAL CATEGORIES IN EACH PLOT

Plot No.	No. of Herd sightings						
	Small			Large		Single	Total
	a mixed 1 male	b mixed multiple males	c bachelor	d Mixed	e Bachelor	f Lone males	
1	3	4	9	16	5	5	42
2	4	4	12	4	7	3	34
3	0	0	2	1	0	1	4
4	4	1	2	0	1	4	12
5	0	0	1	0	0	0	1
6	0	3	1	1	0	0	5
7	0	0	1	1	0	0	2
Total	11	12	28	23	13	13	100

Herd size

Small herds (a + b + c = 51)
+ Large herds (d+e =36)
+ Lone male (f = 13)
Total 100

Herd stucture

Mixed herds (a + b + d = 46)
+ Bachelor herds (c + e = 41)
+ Lone males (f = 13)
Total 100

and indicate various formations to different authors (Mungall *et al.* 1981).

There are two structurally distinct types of herds at Rehekuri (Table 8). In the 100 herds observed 46 had a mixed population with males and females (Tables 8:a+b+d), while 41 had only males (Table 8:c+e). Thirteen isolated lone males were oblerved (Table 8:f). The pattern described by some authors also suggests the formation of purely female herds, which were not observed at Rehekuri during this period. This absence may be related to an abnormally high population density.

The herd size in relation to structural variations showed that there were three structurally distinctive types of small herds, i.e. herds with less than 20 animals. The herd structure of these small groups had two types of small mixed herds. One type having only one male and a few females - Type (a), while the other had more than one male with a few females, - Type (b). These have been placed in separate groups as it appears to be related to breeding biology. There were also small herds formed entirely by a few male blackbuck, - Type (c). The large herds of more than 21 animals were of two types. Herds with several males and females constituted a large mixed group, - Type (d). Large herds were also formed by several adult and subadult males forming bachelor herds, - Type (e). The lone males, - Type (f), remained solitary over a considerable length of time. These were territorial and associated with passing mixed herds within their own territory for brief periods from time to time (Walther *et al.* 1983).

The different herd patterns observed during 100 sightings are shown in Table 8. The frequency with which herds having different structures were sighted was: Small mixed herds with one male and females, 11% (the least common); small mixed herds with multiple males and females, 12%; Large mixed herds, 23%; i.e. mixed herds were encountered in 46% of the sightings. Large bachelor herds constituted 13% of sightings; while small bachelor herds (the commonest type) accounted for 28%. Thus, all-male herds accounted for 41% of sightings. Sightings of lone males accounted for 13% (see inset: Appendix A).

In the 51 small herds sighted, there were 462 animals, while in 36 large herds there were 1659 animals (lone males are excluded). Thus even though small herds were sighted more frequently, the large herds accounted for more than 3 times the number of blackbuck (Appendix A).

The average herd sizes in each herd type are given in Table 9 and Appendix A.

Considering the average herd sizes in different categories of herd structure (Table 9) it is observed that the large mixed herds have the largest number of animals (49.7), followed by large bachelor herds

TABLE 9
AVERAGE HERD SIZE IN RELATION TO HERD STRUCTURE

Small herds			Large herds		Single
a	b	c	d	e	f
Mixed (single male)	Mixed (multiple males)	Bachelor	Mixed	Bachelor	Lone males
9	9.8	8.7	49.7	38.5	1

(38.5), small mixed herds with multiple males (9.8), small mixed herds with a single male (9), while small bachelor herds were the smallest of groupings (8.7) (Appendix A).

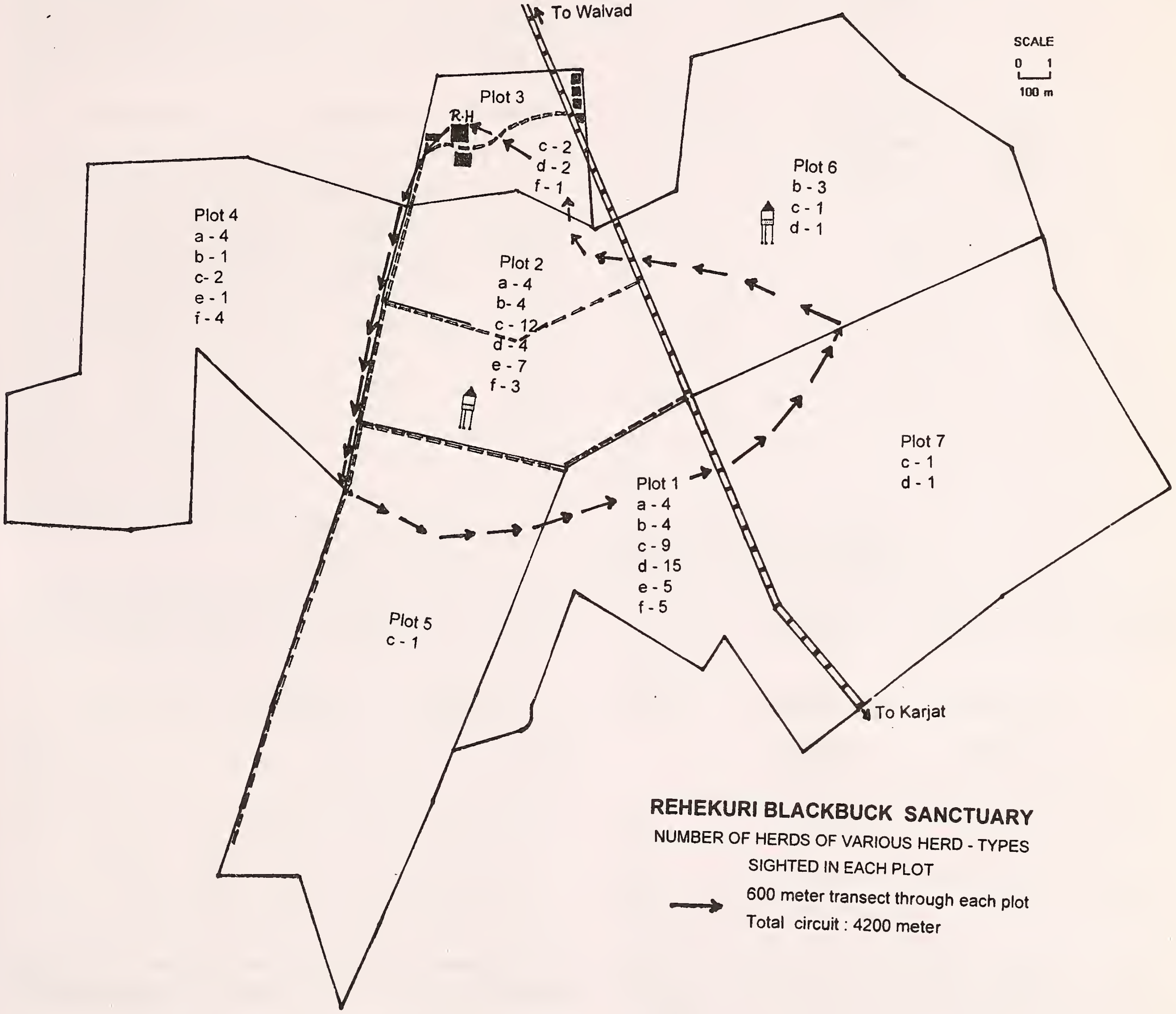
To Walvad
SCALE
0 1
100 m
Plot 3
R·H
c - 2
d - 2
f - 1
Plot 6
b - 3
c - 1
d - 1
Plot 4
a - 4
b - 1
c- 2
e - 1
f - 4
Plot 2
a - 4
b- 4
c - 12
d - 4
e - 7
f - 3
Plot 7
c - 1
d - 1
Plot 1
a - 4
b - 4
c - 9
d - 15
e - 5
f - 5
Plot 5
c - 1
To Karjat
REHEKURI BLACKBUCK SANCTUARY
NUMBER OF HERDS OF VARIOUS HERD - TYPES
SIGHTED IN EACH PLOT
600 meter transect through each plot
Total circuit : 4200 meter

Fig.2. Number of sightings of different types of herds in the seven plots at Rehekuri.

Nair's study (1976) at Point Calimere shows that the average strength of heterosexual herds was 23, of female herds 15, and of male herds 4. Ranjitsinh (1982) found that bachelor groups of over 20 animals each were only seen in high concentration areas when totally numbering over 300 in a restricted area. However he also recorded a bachelor herd of 160 in Velavadar which had a core group of 86 to 88. The same author states that Dharmakumarsinhji recalled having seen male herds of 1500 animals in Velavadar. Ranjitsinh's figure of the largest mixed herds observed are 430 in Velavadar and 243 near Doli, the average size of mixed herds being 20 to 60 animals.

Figure 2 shows the number of sightings of different types of herds in the seven plots at Rehekuri.

TABLE 10

AVERAGE HERD SIZE OF HERD-STRUCTURE CATEGORIES OBSERVED IN EACH PLOT

Plot	Small			Large		Single
	a	b	c	d	e	f
	Mixed with single male	Mixed with multiple males	Bachelor	Mixed	Bachelor	Lone male
1	7.6	11.5	9	45.1	37.6	1
2	3	10	8	34.5	40.4	1
3	0	0	9.5	90	0	1
4	16	12	16.5	0	30	1
5	0	0	2	0	0	0
6	0	5.6	10	28	0	0
7	0	0	2	36	0	0

TABLE 11

AVERAGE HERD SIZE IN PLOTS - (GRASSLAND SUBTYPE)
COMPARED TO ALL OTHER PLOTS (2 - 7) - MODIFIED HABITAT

Plot no.	Small			Large		Single
	a Mixed with a single male	b Mixed with multiple male	c Bachelor	d Mixed	e Bachelor	f Lone male
1	7.6	11.5	9	45.1	37.6	1
2-7	9.5	9	8.6	41.7	39.1	1

An interesting pattern emerges when considering sightings of the different herd types in each plot. As shown earlier, there is a definite relationship between herd size and habitat subtype (Table 6). The relation to structural pattern is similarly shown in Table 8. This shows that large mixed herds were most commonly seen in Plot 1. This was also the area used maximally by territorial males. This evidently provides the females of a large mixed herd the greatest chance of associating with a territorial buck. However, in contrast fewer large bachelor herds were found in Plot 1 compared to Plot 2. This may indicate that these nonterritorial and less dominant bucks prefer to remain out of sight of territorial bucks even though Plot 1 is a more suitable habitat.

The average herd size in various herd-structure categories observed in individual plots is shown in Table 10.

Table 11 shows a comparative analysis of herds in plot 1 and plot 2 to 7 in relation to herd size in different structural categories.

2.5 - Herd - Composition. Male : Female Ratio: It is assumed that the hundred sightings are representative of populations in terms of herd types, structure and the male: female composition (Appendix B).

As shown earlier the small herds numbering less than 20 animals have 3 structural types, those with one male and several females, those with several males and females and the small bachelor groups. The large herds consist of two types. The big mixed aggregations which were usually sighted either on the move or while settled in the open Savanna. If on the move, these were difficult to separate into males and females, and only a total count could be made on some occasions. There were also large bachelor herds. Thirteen sightings of single males were recorded on the circuits.

If the counts were taken as they were, a number of sightings in the big mixed aggregations would have been left out tilting the ratio in favour of the males.

The technical problem was the inability to count males and females separately in large mixed herds especially while they were very close to each other, or running away from disturbance. The male: female ratio in such large mixed herds was obtained in 15 sightings, and could not be obtained in 8 sightings. This has been corrected by assuming that the average proportion observed in large mixed herds is to be expected in these 8 groups as well. In the known group, the male: female ratio is 46:513 or approximately 1:11. The number of animals in the large mixed herds where the composition was not observed directly is 586 in 8 herds, i.e. approximately 73 per herd. Thus it is expected that there should be about 48 males and 538 females in these 8 herds. Thus in the 2121 animals there should be 895 males and 1226 females, i.e. a ratio of 1:1.37

Rashid (1977) found that the male: female ratio at Velavadar was 1:3. He states that normally it should be 1:6 and claims that this indicates a preponderance of males at Velavadar. According to him this indicates a need to translocate or cull surplus animals. It is difficult to understand how the author arrives at the conclusion that the normal ratio should be 1:6. In the past the selective hunting of males may have led to such a highly disproportionate sex ratio. Of 1531 blackbuck counted in Velavadar in 1981, 539 were males, mature and immature (Ranjitsinh 1982). Sharma (1980) gives a male: female ratio of 3:18 (i.e. 1:6), 5: 22 (i.e. 1:4.4) and 5:28 (i.e. 1: 5.6) during non-mating season. These split off into smaller groups of 1:8, 1:11 and 1:14 respectively during the rut. Further it was observed that all-male (bachelor) herd sizes increase up to 10 and occasionally up to 22. Daniel (1967) gives a ratio for Point Calimere of about 1:2. Nair later felt that along with a fall in numbers the male : female ratio had become 1: 4.7. The ratio of 1:1.37 at Rehekuri is similar to that found by several observers from different study sites. However there appears to be a wide variation in the ratio given by different authorities.

RESULTS AND CONCLUSIONS

(1) The Rehekuri blackbuck sanctuary is 2.17 square kilometres in size. However, as the animals are seen fairly frequently in the fields immediately outside it's limits, the area occupied by them covers approximately 4 square kilometres. The population of blackbuck has been estimated to be 250 to 400 animals. This gives population density ranging between 1 to 1.6 per hectare, which is relatively high compared to several other blackbuck areas.

(2) During a one year period, hundred herd sightings were recorded in the mosaic of habitat subtypes in the study area. This shows a preference for the near - natural small grassland patch which constitutes only 9.9% of the total area but had 42%

of herd sightings. In contrast, 90.1% of the area consisting of modified conditions such as plantations and farmland had only 58% of sightings. The ratio of sightings per unit in modified: natural habitat is 1:6.6. The animals thus frequent the natural area 6 times more frequently than the modified area.

(3) In 100 herds sighted, there were 2121 animals. Thus the average herd size at Rehekuri was 21. In 51 sightings, the herds were larger than average in size and in 36 sightings the herds were smaller than average. The 13 lone males were territorial breeding bucks.

(4) The relationship between herd size and structure to habitat variables showed that in the grassland patch, 43% were small herds while 56% were larger than average. In the modified habitat, 70% of sightings were of small herds while 30% were larger than average. Among the small herds 31% of sightings were in grassland and 68% in the modified area, while large herds, 58% of sightings were observed in grassland while 41% were in the modified area. Thus, larger than average herds showed a relatively greater preference for the open grassland area than the smaller herds which preferred the plantation.

(5) The herd structural configuration showed that herds could be classified into mixed herds of males and females in 46 sightings, all male herds in 41 sightings and lone males in 13 sightings. Among smaller than average herds, there were 11 sightings of mixed herds with an average size of 9 animals which had 1 male with a few females; 12 sightings had an average size of 9.8 animals which had more than one male and a few females; and 28 sightings of all male herds with an average size of 8.7. In the large herds 23 were mixed, i.e. males and females with an average size of 49.7 animals; while 13 sightings were observed of bachelor (all male) herds with an average size of 38.5. The 13 lone males were breeding territorial animals which associated with females from the mixed herds when they were in their vicinity.

(6) Though the male: female ratio could not be counted in the case of some of the large mixed herds, the computed ratio in the population of blackbuck in Rehekuri is 1: 1.37.

MANAGEMENT ISSUES

Crop Damage: Blackbuck cause considerable damage to unguarded crops in the immediate vicinity of the sanctuary. It was found that if a crop is left totally unguarded overnight a relatively large proportion of it can be trampled upon and destroyed especially if a large herd happens to enter it. In contrast, crop lands situated further afield show a much smaller degree of damage.

Crop damage increases once the grass in the sanctuary begins to dry. Blackbuck do not feed on crops throughout their growth. "Jowar" is avoided during the initial period of it's growth, it is damaged when about 15-20 cm high. "Bajra" is eaten when it first begins to grow and then after the grain has developed. Although legumes may be eaten during the early phase, they are preferred once the beans form. The Sunflower plant is not eaten and is a good alternate crop as it requires less protection until the flower is formed. However, sunflower residue is not eaten by cattle and thus the farmer would have no fodder to stall feed livestock. A crop well protected by a vigilant guard especially at night is essential if a crop is to be grown close to the sanctuary. Usually it is only the totally unattended crop that suffers very severe damage. Many authors have stated that the blackbuck predominantly feed on the grass and forbs in the crop. This would in fact benefit the farmer by acting as a weed deterrent. Though this may be generally true we have on occasion seen severely damaged crops that were allegedly destroyed by blackbuck by feeding and trampling on it. Krishnan (1972) has stated that inquiry from villagers elicited the information that loss of crops from blackbuck was negligible. He found that at Point Calimere too, the chital and pigs inhibited agriculture more than blackbuck. He claims that these instances show "to what extent a taste for buck-flesh lay behind killing of blackbuck as crop raiders all over India".

At Rehekuri several measures should be instituted such as electric fencing to surround crops close to the sanctuary, developing a rational system of insuring crops on the basis of the farms' distance from the sanctuary as well as instituting crop protection on a co-operative basis.

Management Recommendations

In view of the above, the following recommendations are made to minimise people: wildlife conflict issues and optimizing habitat conditions for the blackbuck.

A) Management of the sanctuary:

1. *Increasing the Size of the Protected Area:* When this Blackbuck Sanctuary, covering an area of 2.17 sq.km was notified, the problem that could arise due to their population growth was not anticipated. The present conflict is a direct consequence of a very high but localized overabundance. To encourage a wider dispersal of the present population another four or five similar plots the Forest Department totally covering an area of about 20 sq.km should be notified. This would provide a cluster of several grassland patches which could be closed by rotation for better rejuvenation of grass. Once the population disperses into these areas the localized over abundance and high density will decrease and the serious crop damage affecting the few farmers who live around the sanctuary would be substantially reduced. A few 'malki' areas within and on the borders of the sanctuary that are most severely damaged should be acquired by the Forest Department and adequate compensation paid to the farmers. These areas could be developed using a rapidly growing grass species. There has been a suggestion that tranquilizing and translocating animals should be attempted to reduce the population of blackbuck. This would be prohibitively expensive and carry a risk of mortality. To reduce the density appreciably more than half the population would have to be moved. This is an impractical suggestion. Encouraging dispersal which will reduce density to acceptable levels seems to be the only practical solution at present.

2. *Rangeland management within and outside the Sanctuary:* Closing off certain areas during the growing season will improve the total biomass of grass considerably. To set up a rotational pattern of grazing both for the antelope in the sanctuary and for the livestock outside is essential. This can only be done effectively if several other patches of grassland are notified and protected. The presence of adequate grazing for blackbuck will reduce their dependence on crops.

3. *Fodder Supplement:* The blackbuck should be given fodder supplements at several locations in the sanctuary. Branches and leaves from *Ziziphus* and *Acacia* trees can be collected and stored as stall feed for summer. The branches must be lopped from well above the existing browse line to ensure that the animals can reach the lower branches on their own.

4. *Modifications in present Management:*

a) 'Lure crops': The crops planted by the Forest Department to attract blackbuck result in bald patches soon after they are grazed off by the blackbuck. These are not recolonised by grass even in subsequent years. This reduces the total biomass of fodder available in the sanctuary. The Forest Department contends that 'lure crops' help in gaining confidence of local farmers as they feel that the Forest Department is attempting to reduce the dependence of the blackbuck on their farmland by substituting crops of their own. Though this may be a psychological factor in improving relations between managers and people it is producing a further decrease in availability of forage. The area under 'lure crops' must therefore be decreased considerably, and substituted by grasses that can improve the biomass in the area and prevent further erosion of soil.

b) Plantation: The Department continues to plant trees both in the sanctuary and the neighbouring DPAP plots. This should be decreased and the emphasis shifted to developing the area as a grassland. A thinning of those tree species that are not browsed by blackbuck should be undertaken. (Species such a Eucalyptus, *Dalbergia* and Neem which are less browsed by blackbuck should be removed to reduce the canopy. *Acacia* and *Ziziphus* are browsed and thus should not be removed). Thinning will also provide a more natural Savanna - like appearance as it will break the monotony of the straight plantation rows which is aesthetically unacceptable in a 'Wildlife Sanctuary'. The wood collected during the thinning operation should be given free of cost to local people so that they begin to see the Protected Area as directly beneficial.

c) Blackbuck dung piles : Since these act as territorial markers they should be left undisturbed. The practice of collecting them for the Forest Department Nursery or garden should not be permitted as this has been observed to lead to a disruption in territoriality and social behaviour with dispersal of blackbuck into the surrounding croplands.

d) Tourism: Though one would wish to increase wildlife tourism to enhance conservation awareness in the area the present form of uncontrolled and uniformed tourism is a source of serious disturbance.

e) Blackbuck fawns: Several abandoned fawns have been found in the sanctuary. Their mortality as reported by the forest department was very high. These should be carefully reared, ear tagged, and released in the sanctuary. The tagged animals would provide information on several behavioral aspects of blackbuck.

f) Disturbance : No further roads should be constructed through the sanctuary area.

h) Research: Census techniques must be standardized and experts not connected with sanctuary management requested to be present.

i) Education: An audio visual on the importance of protecting blackbuck should be specially designed for the local people in Marathi. This should be shown in schools and at village market places around Rehekuri. The same A-V can be used in the sanctuary for tourists prior to entry.

B) Management outside Sanctuary Limits:

1. Crop Protection co-operatives: Preliminary observations indicate that the extent of crop damage incurred by an individual farmer is proportional to the vigilance with which he guards his crop. It is also related to the proximity of the crop to the sanctuary. This requires further study to spatially quantify the amount of damage. However if the villagers are encouraged to form their own crop protection co-operatives they could collectively guard their crops more effectively with much less individual effort.

2. Crop Insurance Schemes: Since crop damage by blackbuck occurs primarily if the crop is left unprotected it is difficult to provide compensation for the damage. If, however, crop damage in the presence of adequate protection is quantified, this could be used as a baseline to provide compensation for insured crops. Instead of assessing each claim in detail individually, the amount to be paid for the damage could be claimed on predetermined criteria based on the type of crop and it's distance from the sanctuary. This would avoid undue delays in settling claims and compensate the farmer adequately. A computer model which takes into account, the distance of the crop from the sanctuary, the number of times blackbuck visit that area and the type of crops are a few relevant parameters that must be used to quantify expected damage.

3. Cropping patterns: A few farmers who have severe crop damage due to the close proximity of their farm could be encouraged to change their cropping pattern. Such farms could benefit from electric fencing.

4. Change in land use patterns: In certain areas farmers could be encouraged to grow palatable grasses instead of crops. This would provide fodder for stall feeding cattle and the residual grass would support the blackbuck.

5. Development of Grassland Patches outside Rehekuri Sanctuary: There are several areas under the jurisdiction of the Forest Department in Karjat taluka outside the sanctuary. It is suggested that these are managed intensively as grasslands. A few shrubs and trees indigenous to the Deccan Plateau such as *Acacia* and *Ziziphus* may be randomly planted in them to provide a natural Savanna-like appearance. Once these are developed the blackbuck will disperse into them thus reducing the very high population density at Rehekuri. Though this dispersed population will continue to collectively damage the same amount of crops, the lower density would reduce the damage suffered by individual farmers.

6. Poaching: A few farmers have reported that blackbuck are being shot at night outside sanctuary limit. This must be ascertained and preventive steps instituted.

POSSIBLE STRATEGIES FOR BLACKBUCK MANAGEMANT IN INDIA

The general principle for blackbuck habitat management should aim at encouraging a of the animals into smaller interlinked populations rather than into single, fragmented, high-density aggregations. This would lower the intensity of crop damage to acceptable levels. Culling at this point in time would lead to a serious negative impact on the gradually growing conservation awareness in the country. Thus, alternate site-specific management practices based on the suggestions evolved for Rehekuri, must be developed for other existing Protected areas around which conflict is becoming a serious problem.

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APPENDIX A
HERD STRUCTURE

1. No. of blackbuck in different herd sizes
2. Mean herd size in population
3. Mean herd sizes in different herd compositions (ie. M:F Ratio)

Size	1	2	3-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	56-60	85-90	195-200
Head Class	1f	2a	5a	6a	12a	16a	21d	26d	35d	40d	42d	50e	59d	90d	200d
	1f	2a	4b	6a	14b	16a	25d	30d	33d	40d	42d	50e	56d	90d	
	1f	2a	5b	10b	12b	16a	24d	28d	33d	36d	42d	50e		90d	
	1f	2c	4b	6b	12b	16a	21d	30e	32e	40e	42d				
	1f	2c	3c	6b	12c	18b		28e	32e	40e	45e				
	1f	2c	4c	7b	11c	20b		30e	34e	40e					
	1f		3c	10c	15c	20c									
	1f		3c	7c	12c	16c									
	1f		5c	8c	13c	16c									
	1f		3c	7c		20c									
	1f			10c											
	1f			10c											
	1f			8c											
				9c											
				7c											
				7c											
Total Animals	13	12	39	124	113	174	91	172	199	236	213	150	115	270	200 = 2121
Herd Sightings	13	6	10	16	9	10	4	6	6	6	5	3	2	3	1 = 100

$$\frac{\text{Total animals}}{\text{Herd sightings}} = \frac{2121}{100} = 21.2 \text{ Mean herd size}$$

Thus 2 - 20 = Small herds (a), (b), (c). Over 21 = Large herds (d), (e). One male = Lone territorial buck (f)

Herd Structure	Total of blackbuck	Number of sightings	Mean herd size
(a) = Small mixed herd with 1 male	99	11	9
(b) = Small mixed herd with many males	118	12	9.8
(c) = Small bachelor herd	245	28	8.7
(d) = Large mixed herd	1145	23	49.7
(e) = Large bachelor herd	501	13	38.5
(f) = Lone male	13	13	1
Total	2121	100	

APPENDIX B

Plot	Small			Large		Lone	
	Mixed		Bachelor	Mixed	Bachelor		
	One Male	Multi Male					
	a	b	c	d	e	f	
	M:F	M:F	M	M:F	M	M	
1	1:11=12	3:15 = 18	12	1:20 =21	40	1	
	1:4 =5	4:6 = 10	20	90	32	1	
	1:5 = 6	3:11 = 14	3	25	32	1	
		2: 2 = 04	4	200	34	1	
			7	2:40 = 42	50	1	
			8	2:40 = 42			
			7	5:54 =59			
			10	2:54 =56			
			10	40			
				2:40 = 42			
				5:30 =35			
				4: 20 =24			
				90			
				21			
				3:30 =33			
				3:30 = 33			
Herd Sightings	3	4	9	16	5	5	= 42
2	1:1 = 2	3:02 = 05	2	2:40 =42	50	1	
	1:1 = 2	3:17 = 20	3	1:25= 26	30	1	
	1;1 = 2	2:04 = 06	11	5;35 =40	28	1	
	1:5 = 6	2:10 = 12	8	30	50		
			3		45		
			5		40		
			9		40		
			3				
			16				
			7				
			16				
			15				

Herd Sightings	4	4	12	4	7	3	=34
3			7 12	90		1	
Herd Sightings			2	1		1	= 4
4	1:15 =16 1:15 =16 1:15 =16 1:15 =16	2:10 =12	20 13		30	1 1 1 1	
Herd Sightings	4	1	2		1	4	= 12
5			2				
Herd Sightings			1				= 1
6		2:4 = 6 3:4 = 7 2:2 = 4	10	8:20 = 28			
Herd Sightings		3	1	1			=5
7			2	1:35=36			
Herd Sightings			1	1			= 2
Total Sightings	11	12	28	23	13	13	100
M:F = Total	11:88=99 (1:8)	31:87=118 (1=2.8)	245	(X Known) 46:513=559 (Y Unknown) ? 586 i.e. 48:538 X + Y 94:1051 = 1145 (1:11.2)	501	13	2121

Therefore Males = 895, Females = 1226
i.e. Total = 2121

M:F = 1 : 1.37

THE DIEL ACTIVITY PATTERN OF INDIAN PYTHON (*PYTHON MOLURUS MOLURUS* LINN.) AT KEOLADEO NATIONAL PARK, BHARATPUR, RAJASTHAN[1]

KARMAVIR BHATT AND B.C.CHOUDHURY[2]

(*With four text - figures*)

Key words : Indian python, activity pattern,diurnal, bimodal, crepuscular, burrow - microclimate, prey activity

The diel activity pattern of the Indian python (*Python molurus molurus* LINN.) at Keoladeo National Park, Bharatpur, India was studied in an intensive study area of 0.5 Sq. Km. The activity pattern of pythons was estimated by monitoring a permanent transect every four hours, on a 24 hr (diel) basis, to record python tracks and sightings. The diel variations in ambient temperature, humidity, burrow-microclimate and prey activity were also quantified.

Results show a shift in diel activity pattern with seasons. It was diurnal in winter, uniform throughout spring and bimodal-crepuscular in summer. Temperature and humidity affected the pattern considerably. There was no significant correlation between python activity and other factors quantified. The microclimate variation existing between outside and inside the burrows possibly plays an important role in occupation of the burrow and the surface diel activity pattern. Other factors not quantified during this study like reproductive behaviour, body size and biotic disturbances are also suspected to be responsible for the observed diel activity pattern of pythons. The activity pattern is influenced by a combination of various abiotic, biotic and endogenous factors.

INTRODUCTION

Reptiles are not continuously active but rather have discreet activity periods, daily as well as seasonally (Harker 1958). The broad activity pattern on a 24 hrs time scale is defined as the diel activity pattern of an animal, which tends to vary during different seasons. Owing to the poikilothermic nature of reptiles, characteristics of the thermal environment constitute an important determinant of their activity (Bogert 1949, Heatwole 1976, Porter 1972). Within the constraints imposed by the physical environment, the biological factors like food availability, predation avoidance and competition also influence reptilian activity. Endogenous factors like reproductive cycles also play a critical role in governing the activity of reptiles (Heatwole 1976, Gibbons and Semlitsch 1987).

Diel activity of snakes in relation to the physical environment has been extensively studied in temperate species (Gibbons and Semlitsch 1987). Most studies document only the timing of activity, although some have perceived reasons for the pattern. Studies done by Heckrotte (1962), Landreth (1973) and Sanders and Jacob (1980) on small-bodied colubrid snakes suggest a general trend that at low temperatures snakes tend to be 'diurnal', at intermediate temperatures they show a bimodal pattern of being ‘crepuscular’ and at the highest temperature they are ‘nocturnal’.

This study deals with the diel activity pattern of free ranging Indian pythons (*Python molurus molurus* Linn.), the most widely distributed python species of the Indian subcontinent. Pythons are found in a variety of habitats, from dry scrub forest to tropical rain forest (Daniel 1983). It is one of the largest snakes of the Indian subcontinent, with a maximum recorded length of up to 5.8 m (Daniel 1983).

MATERIALS AND METHODS

The study was conducted at Keoladeo National Park (KNP), Bharatpur, India (27° 7.6' to 27° 12.2' N, 77° 29.5' to 77° 33.9' E). The park falls under the semi-arid biogeographic zone in the Yamuna river

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flood plains (Rodgers and Panwar 1988). KNP is an artificial wetland which attracts a variety of winter migrant waterfowl. The area of the park is 29 Sq.Km. The general topography of KNP is flat with a gentle slope towards the center forming a depression which constitutes the wetland, the total area of which is about 8.5 Sq.Km. The rest of the terrestrial area is characterised by a mosaic of alluvial soil patches with *Salvadora - Prosopis* community followed by *Mitragyna - Acacia* woodlands and tall *Vetiveria* grasslands (Perennou and Ramesh 1987).

The study was conducted in an approximately 0.5 sq.km of saline patch which is here designated the intensive study area (ISA). The ISA consisted of 8 python burrow clusters. These are porcupine burrows used by pythons, here referred as P1, P1A, P2, P3, P3A, P4, P5 and P6 (Fig. 1).

Most of the ISA ground substrate was thin saline soil, conducive for observing indirect python evidence like tracks and spoor marks. The thick alluvial soil present on the periphery of the ISA supports woodlands, wetlands and grasslands. The vegetation in the ISA was dry scrub jungle dominated by *Salvadora persica, S. oleoides* and *Prosopis chilensis*.

In the ISA two square transects, one outer and one inner, were laid taking into consideration the location of all the python burrows (Fig. 1). The total length of both the transects was 2.4 km. The existing mud road passing through the ISA was used as a bicycle transect and was monitored regularly after completion of foot transect. In the outer transect (ABCD) from road near P1 to road near P6 was not sampled as the soil cover in this region was not suitable for obtaining indirect evidence in the form of tracks and for sighting pythons.

A day was divided into six four hourly time classes starting from 0000 hrs. to 2400 hrs. Both the transects were sampled for at least two time classes in a day. The day (0600 - 1800 hrs) and night time classes (1800 - 0600 hrs) were sampled on two subsequent dates. For recording the activity of pythons on the transect, indirect evidences of activity in the form of number of fresh tracks were noted. In order to avoid double counting of tracks during each sampling, all fresh tracks were either obliterated or marked. During each sampling the number of sightings of pythons were also noted.

The basic assumption involved here is that the frequency of encountering fresh tracks on the permanent transects is a function of the actual level of activity of the population.

The activity level for any time class can be estimated as an activity index (AI) which is expressed as:

A I = Tracks encountered / the number of times transects were walked in a time class.

From 1 December 1990 to 30 April 1991, each month was divided into two halves, each is described here as a fortnight period, hence the whole study duration was divided into 10 such fortnight periods. December - I to February -I (5 fortnight periods) were regarded as winter and from February - II to April - II (5 fortnight periods) as summer.

Ambient temperature and ambient humidity were recorded on a thermohygrograph installed in a standard Stevenson screen, located approximately 2 km from ISA.

The ambient temperature and humidity records at 0000 hrs, 0800 hrs, 1200hrs, 1600 hrs and 2000 hrs, were taken for comparison with the diel activity pattern for the corresponding time classes. The mean temperature and humidity for a particular time class in all 10 fortnight periods were also calculated.

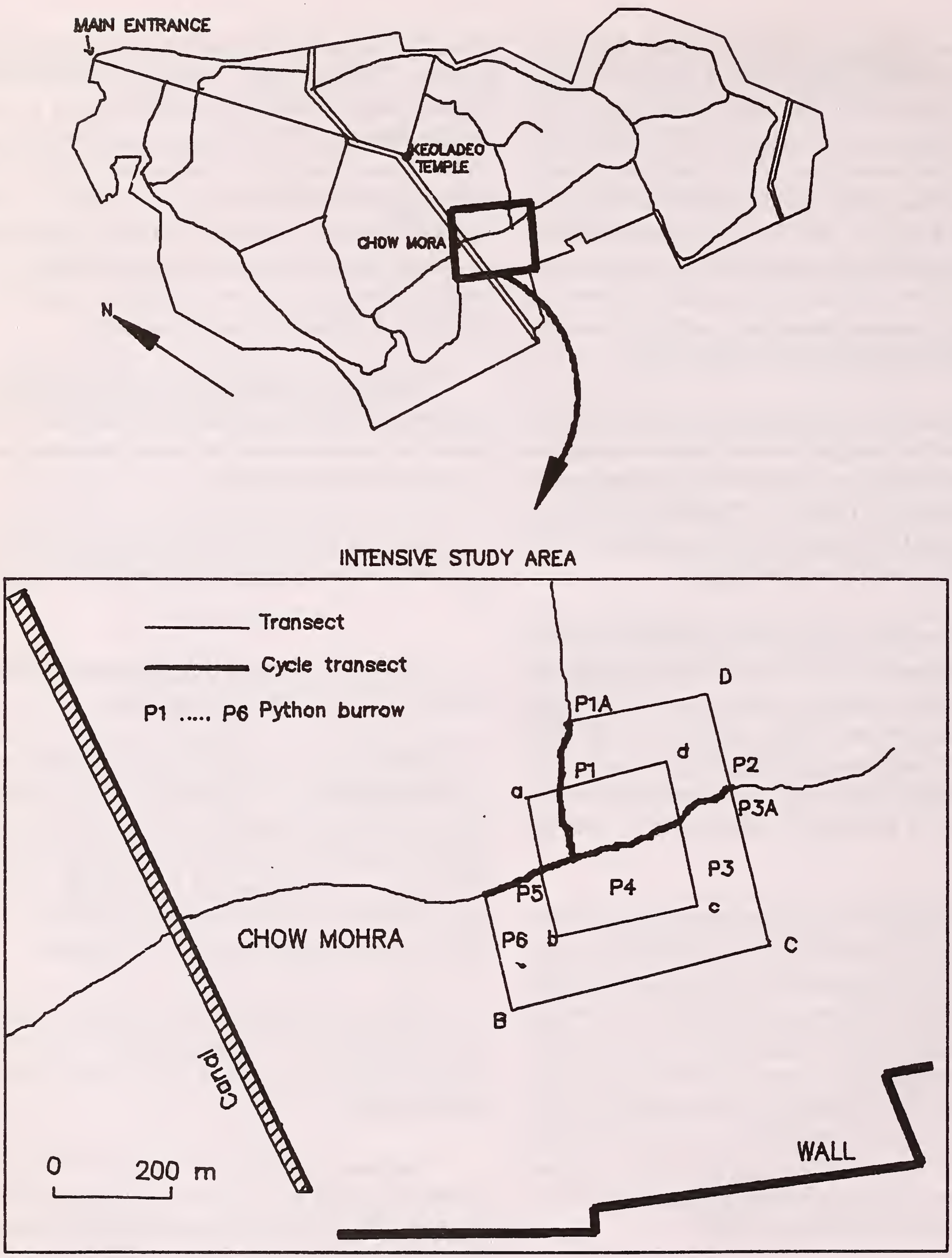
MAIN ENTRANCE
KEOLADEO TEMPLE
CHOW MORA
N
INTENSIVE STUDY AREA
Transect
Cycle transect
P1 ..... P6 Python burrow
P1A
P1
P2
P3A
P3
P4
P5
P6
a
b
c
d
B
C
D
CHOW MOHRA
Canal
WALL
0 200 m

Fig. 1. The study area, Keoladeo National Park (KNP), Bharatpur and details of the Intensive Study Area(ISA) showing locations of Python burrows and transect lines.

Temperature and humidity at 100 cm depth in the python burrows were measured with the help of a thermohygrometer (323i Trace model, England) fixed on an extendable rod. The microclimate of two selected burrows, P5 and P6 was consistently sampled throughout the study. The burrow temperature and humidity mean for each time class of each fortnight period was compared with the diel activity pattern for the corresponding time class and period.

While walking transect, the number of known python prey species were counted using a tally counter. Mean number of prey encountered for each time class in each period was assessed as an activity index of prey activity for that particular time class and period.

Results

Pythons were found to be chiefly diurnal during the study duration as the concentration of the activity was observed in the day hour (0600 - 1800 hrs) time classes (Fig. 2). Activity in the early and late winter fortnight periods (December -II and February - I) was bimodal, during mid winter fortnight period (December -II, January I and January -II) activity was unimodal. An even activity trend was observed during early summer fortnight periods (February -II to March -II). The activity trend in the late summer fortnight periods (April-I and April II) was, however, bimodal - crepuscular (Fig. 2). The activity levels shifted greatly even within a specific time class of the day as also during periods. One way ANOVA conducted on AI (Table 1) by fortnight periods and time classes suggests that, there is a significant difference between activity levels of time classes (ANOVA;/F = 4.7204 P = 0.0012), but no difference in the activity level of each period (ANOVA/; F = 1.3169 P = 0.2527).

Sightings of pythons was also considered an indication of activity. Out of a total of 271 sightings, the maximum sightings (of 29 individuals) occurred in the January II fortnight period during the time class 1200 - 1600 hrs, followed by sightings of 24 individuals in February - II fortnight period in 0800 - 1200 hrs. Sightings of pythons during different fortnight periods were restricted to certain time classes; most of the sightings were during winter (Fig 3).

Ambient temperatures and burrow temperatures exhibited similar trends during day hours but during night hours burrow temperatures were higher than ambient temperatures. Peak temperatures were noted during the 1200 - 1600 hrs time class during winter, and shifted to the 1600-2000 hrs time class in summer. A trough of ambient and burrow temperature was observed during the 0000 - 0400 hrs time class and this remained consistent for the whole of the study duration (Fig 4).

Ambient relative humidity (RH) and burrow RH showed a similar but inverse trend; during day time burrow humidity was higher than ambient humidity, while night burrow RH was lower than the ambient RH (Fig 4).

The diel activity pattern of prey was consistently bimodal with a peak at morning and evening hours for all the fortnight periods. The level of the prey activity, however, decreased with the onset of summer.

Scatterplot between activity index and the above factors does not suggest any linear relation between them. Stepwise multiple regression was tried with the current set of data and none of the variables (factors) were correlated at the preset P value of 0.05.

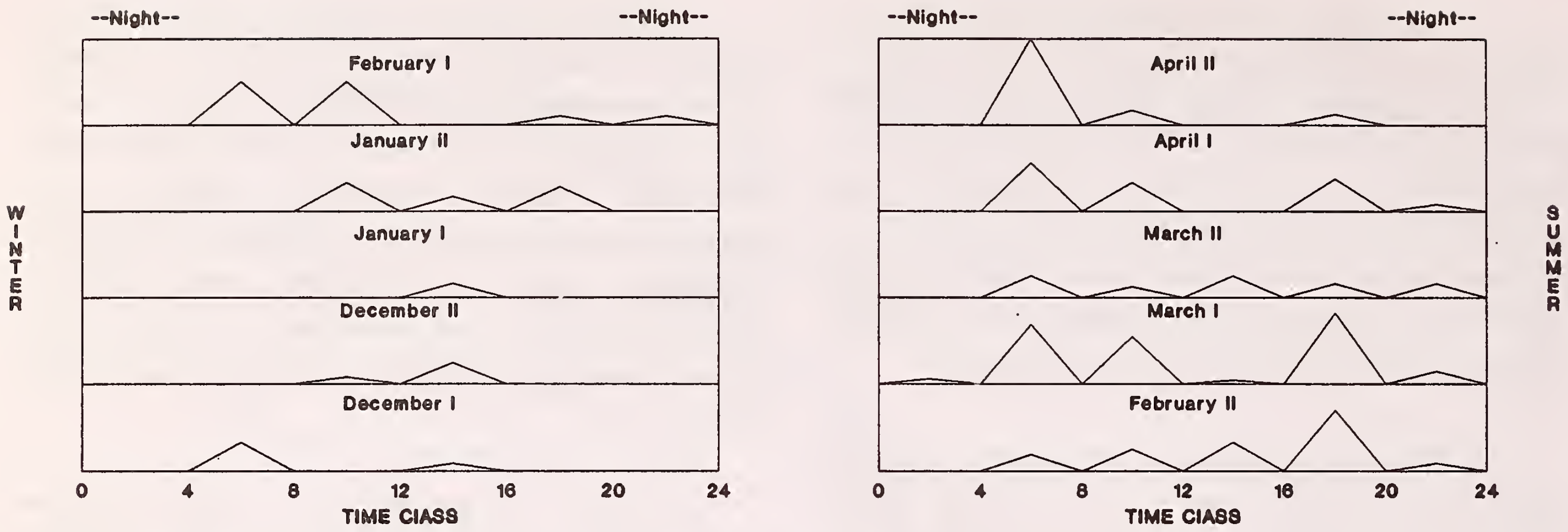

Fig. 2. Diurnal python activitiy during the study period. In winter, activity is restricted to day hours. The summer activity tends to be 'bimodal' with activity peaks during early noon and late afternoons.

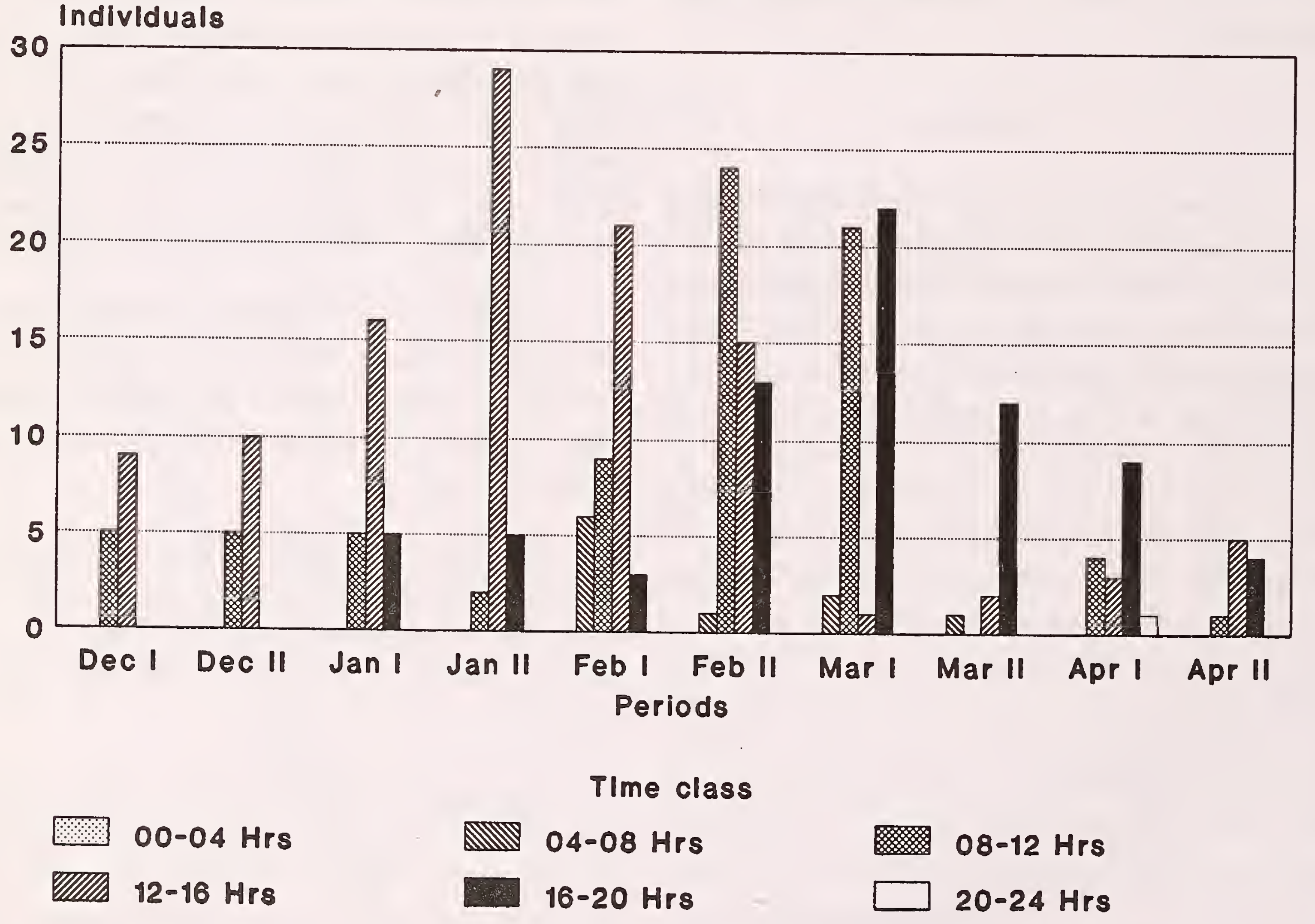

Fig.3. Sighting of pythons during the study period. Corresponding with increased activity of pythons, sightings increased during late winter and early summer.

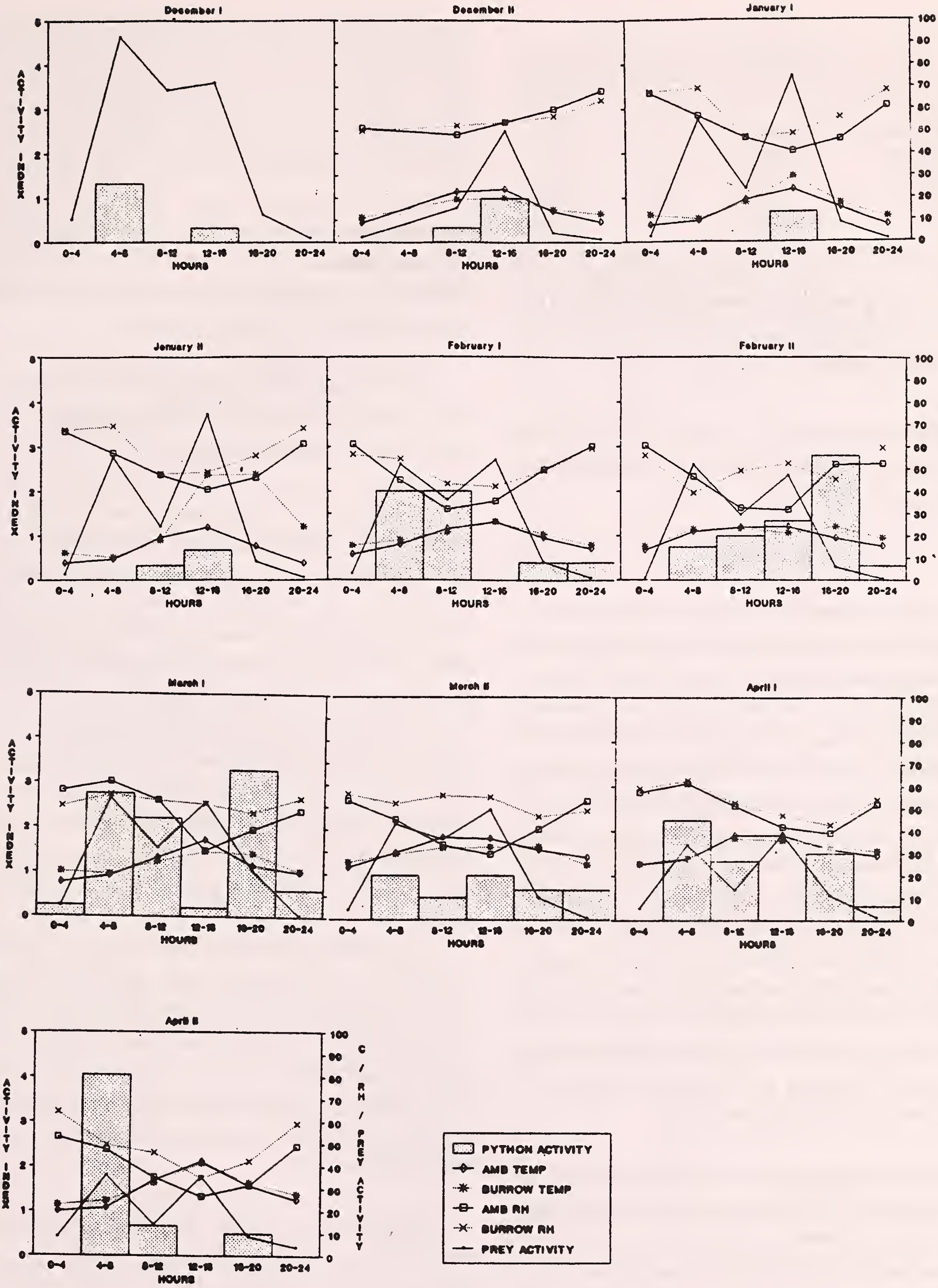

Fig. 4. Relationship of various factors with python activity during the fortnight periods.

TABLE 1

Factors	Correlation	Relationship	P Value
Ambient temperature	0.1696	+ve	0.22
Burrow temperature	0.2591	+ve	0.31
Ambient humidity	-0.1731	-ve	0.125
Burrow humidity	-0.2555	-ve	0.065
Prey activity	0.2337	+ve	0.092

The Pearson correlation coefficient was calculated (using statistical package SPSS/PC+) to test the relationship between the estimated factors and the activity pattern of pythons.

The Pearson correlation coefficient calculated for the activity for the activity index with each of the variables is given in Table 1.

DISCUSSION

The Diel Activity Pattern: The observed trend of the diel activity pattern of the Indian python is different from that observed in small-bodied snakes by Heckrotte (1962), Landreth (1973) and Sanders and Jacob (1980). The smaller snakes studied by the above mentioned workers had a unimodal (nocturnal) diel activity pattern in summer and a bimodal activity pattern in spring. In the present study pythons showed a uniform diel activity pattern in spring which becomes bimodel (crepuscular) in summer. The results obtained in KNP do not agree with the work done by Slip and Shine (1988) on diamond pythons (*Morelia spilota*) in Australia where activity, irrespective of season, was confined to early hours of the day. Work done on *Eryx conicus*, a close relative of the python, by Griffiths (1984) demonstrated that the species is exclusively nocturnal.

The present study agrees with Platt (1969) who found two species of *Heterodon* (hog-nosed snakes) in Kansas active during early morning and late afternoon on hot days and in late morning on cooler days.

While the trend of the diel activity pattern obtained based on indirect evidence (tracks), is a manifestation of only one type of activity (moving), there are other activities like basking and postural thermoregulatory activities, which can be broadly classified as stationary activities. The data (Fig. 3) indicates that during winter sightings of python were considerably higher. And the sighting frequency tends to decrease with the onset of summer months. The trend from sighting data is totally opposite to the trend obtained from the tracks data.

The decrease in sighting of the pythons with onset of warmer months can be explained on the basis of the following reasons.

a) *Emigration of pythons from ISA*: The most frequent place where sightings were high was near burrows in winter. By onset of warmer months the availability of precise optimum microclimate increases outside the burrow and the movement of snakes from the hibernaculum commences towards breeding and foraging grounds (Huey *et al.* 1989, Jacob and Painter 1980 and Sexton and Hunt 1980). Similar events can be expected in Indian pythons also as more tracks were encountered during summer fortnight periods and sightings at burrows decreased. This suggests that most of the pythons were moving out of the ISA with the onset of warmer months.

b) *Change in basking behaviour*: A stretched out python is conspicuous while basking. With the onset of warmer months requirement for basking decreases which result in a decrease in sightings of pythons. Telemetry work done by Slip and Shine (1988) on diamond pythons also attribute the decrease in sightings in warmer months to the alteration in the basking behaviour.

Relationship of the Activity with Abiotic Factors: The relationship between temperature and python activity was curvilinear. Such type of curvilinear relation between temperature and activity has also been noted by other workers (Gibbons and Semlitsch 1987, Semlitsch *et al.* 1981). The relationship is also responsible for absence of significant correlations between activity and temperature.

The trend in the observed activity Pattern can be explained by temperature to a certain extent. As would be expected, there was an increase in activity with an increase in temperature in fortnight periods December II and January II (Fig. 4). It should be noted that the increase in temperature does not always mean an increase in activity, rather peak activity occurs only at the favourable temperature zone (20° - 30°C). Activity is more dependent on the occurrence of a favourable temperature zone in time and space. In winter, most activity occurred during the middle of the day. As the season progressed, favourable temperatures would occur earlier and later in the day or at night, resulting in changes in the diel activity rhythms in different fortnight periods.

The argument therefore holds good to the relation of activity and temperature, only during winter months (December I to February I). The crepuscular activity in summer can be explained on the basis of Peterson's (1987) experiment on garter snakes that, during morning snakes warm up quickly and attain preferred body temperature for movement, resulting in greater activity. The movement itself (activity) raises the body temperature of snakes further and snakes seek a microclimate where they can radiate the extra heat attained by movement. Johnson *et al.* (1975) noted in Australian pythons that in summer pythons enter subterranean environments which are characterised by a stable microclimate. A similar phenomenon is suspected to be the cause of the lull in activity of Indian pythons during day time in summer, though some amount of movement occurs in order to utilise available favourable micro-habitats outside the burrows (Fig. 4).

Similarly, relationship between humidity and temperature (Fig. 4) would suggest a mechanism for immediate compensation of activity. In general, relative humidity and temperature vary inversely with each other. The increase in RH would in part compensate for the decrease in activity by a temperature drop. The correlation analysis ($r = -0.1731$ $P < 0.05$), also supports the argument of inverse relationship of humidity with activity. The absence of activity during certain times (afternoon time classes) in certain periods (February to April) can be explained on the basis of humidity regimes present outside the burrow even though the temperature regimes outside the burrows are favourable. It is evident (Fig. 4), that very low humidity and high temperatures during day time classes can force the python to retreat inside the burrow.

The relationship of burrow microclimate is not discussed in detail here as the method employed to quantify the burrow microclimate was found insufficient to give a very realistic picture on burrow microclimate actually used. It is evident that burrows provide a favourable microclimate to the pythons in all of the periods (Fig. 4), i.e. warmer and drier at night, cooler and moist during day in comparison to the microclimate outside the burrow. Such a climatic gradient between burrow and the atmosphere was found to affect the activity pattern of the snakes in many cases (Brown and Parker 1976, Huey *et al.* 1989, Jacob and Painter 1980, Sexton and Hunt 1980). Pythons are considerably active outside the burrow during certain times of day and season (February-March) even though the climatic conditions inside the burrow are much more favourable. Such activities can be attributed to endogenous factors like foraging and body thermal inertia. Any movement (activity) outside the burrow during the much cooler winter months, therefore may be attributed to basking to increase body temperature or inter burrow movement in response to disturbance. The present methodology and results did not examine whether the activity rhythms in Indian python is governed by endogenous factors or not. But, the activity trends during the spring months (February and March) can be attributed to one such endogenous factor-the reproductive behaviour of the pythons. Earlier workers (Bhupathy and Vijayan 1989) observed that the mating season of pythons in KNP is during February - March. Hence, the activity pattern can be expected to be partly governed by reproductive behaviour as there could be considerably more movement in search of mates. Moreover, the temperature during this period was more or less uniform throughout the day. Both these factors operating during spring periods reflect the activity pattern as evenly spread throughout the day (Fig 4).

Relationship of the Activity with biotic Factors: While comparing the activity patterns of Australian and north American snakes species, Shine (1979) noted that larger species tend to be active when a majority of their prey items are most active. The effect of prey however was examined as prey activity pattern. During the entire study span at KNP the diel activity of prey was consistently the same, with two distinct peaks, one in the morning and the other in the evening (Fig. 4). The diel activity of the python, however, showed great variation. Hence the prey activity pattern and diel activity pattern of python showed a very weak correlation ($r = 0.2337$, $P > 0.05$).

The fact that pythons during this present study did not show any strong relationship with prey activity, may be because of their foraging habits. In general the python is a generalist opportunistic feeder. During this study period not even one python was observed feeding and only seventeen scats were examined for diet. The scanty data suggest that birds constituted 82% of diet and mammals 12%. Preferred body temperature for feeding is around 30-32°C (Cogger and Halmes 1960, Johnson 1972, Webb and Heatwole 1971). This may be partly attained after the fortnightly period, February II, hence food intake during winter can be expected to be very low supporting the inconclusive relationship of python and prey.

Tourist activity, observer disturbance and activity pattern of the feral cattle in the park were not considered major factors influencing python activity in the present study. However, the density and movement of feral cattle may have a significant role in the activity patterns of the pythons in KNP considering the fact that cattle trampling is one of the major causes of adult python mortality (Bhupathy and Vijayan 1989).

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ICHTHYOFAUNA OF RAJASTHAN STATE (INDIA)[1]

M.S. Johal, J.S. Chahal and K.K. Tandon[2]

Key words : ichthyofauna, Rajasthan state (India), zoogeography

Between May 1986 to March 1990 as many as 95 fish species belonging to 52 genera, 7 orders, 5 superorders and 2 cohorts were listed from Rajasthan State. Among these fifteen species were recorded for the first time. However eighteen species have disappeared through changed ecological conditions. The fish fauna of the state is a mixture of three elements, namely Western Himalayas, Aravallis and Peninsular India.

Introduction

A comprehensive knowledge of the fauna of a State is a pre-requisite for rational planning and successful execution of biological programmes. Fishes (as a whole) constitute an important group among the vertebrates because of their economic importance.

Rajasthan is the second largest State of India (area-wise), having an area of 3,42,217 sq.km and is ranked 12th among the Indian States as far as the annual fish catch is concerned (Jhingran 1991).

In the absence of a comprehensive list of the fishes of Rajasthan, an extensive fish survey was conducted during 1986-1990 and the results are presented in the present communication. We are of the view that the findings of this survey will help future fishery workers to plan strategies to increase fish production.

Topography

Rajasthan State lies between latitude 23°03' - 30°10' N and longitude 69°30' - 78°17' E.

The aquatic resources of this State consists of five river systems, namely Chambal, Banas, Luni, North-east river system and Western Ghats river system, reservoirs (Rana Pratap Sagar, Jaisamand Lake, Ghagger river depressions in Bikaner division, Saliserh-Jaisamand, Morre, Baretha, Ghambhiri, Bajaj Sagar, Kadana backwater, Kota-Baraz, Ramgarh Lake, Gudha reservoir, Angi reservoir and Jawai Bandh), irrigation canals and their distributaries, numerous village ponds and water-logged areas.

Material and Methods

Fishes were collected by us using different types of nets or with the help of local fishermen or the State Fisheries Department. Small fishes were directly transferred to 10% formaldehyde solution. Care was taken that fins remained stretched and helped in easy counting of rays. In the laboratory they were washed in running tap water and preserved in 10% formaldehyde solution after identification, classification and assigning of catalogue number. Large sized fishes were given an injection of 10% formaldehyde solution to prevent spoilage of visceral organs.

For the purpose of identification the works of Hamilton (1822), Day (1878), Misra (1962), Johal and Tandon (1979, 1980), Srivastava (1980), Jayaram (1981) and Datta Munshi and Srivastava (1988) were consulted.

Observations and Discussion

95 species belonging to 52 genera, 7 orders, 5 superorders and 2 cohorts are reported in the following pages. Berg's (1940) classification as modified by

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Greenwood *et al.* (1966, 1967) has been followed. The arrangement of fishes given in this list is according to Jayaram (1981) with minor changes.

Class: Pisces
Subclass: Teleostomi
Cohort: Taeniopaedia
Superorder: Clupeomorpha
Order: Clupeiformes
Family: CLUPEIDAE
Subfamily: Alosinae
Genus: *Gudusia* Fowler

1.*Gudusia chapra* (Hamilton)

Cohort: Archaeophylaces
Superorder: Osteoglossomorpha
Order: Osteoglossiformes
Family: NOTOPTERIDAE
Genus: *Notopterus* Lacépède

2. *Notopterus chitala* (Hamilton)

3. *N. notopterus* (Pallas)

Cohort: Euteleostei
Superorder: Ostariophysi
Order: Cypriniformes
Family: CYPRINIDAE
Subfamily Cultrinae
Genus: *Chela* Hamilton

*4. *Chela (Chela) cachius* (Hamilton)

Genus: *Salmostoma* Swainson

5. *Salmostoma bacaila* (Hamilton)

6. *S. gora* (Hamilton)

*7. *S.phulo orissaensis* Banarescu

*8. *S. phulo punjabensis* (Day)

Subfamily: Hypophthalmichthyinae

Genus : *Hypoththalmichthys* Bleeker

9. *Hypophthalmichthys molitrix* (Valenciennes)

Subfamily: Rasborinae
Genus: *Aspidoparia* Heckel

10. *Aspidoparia morar* (Hamilton)

Genus: *Amblypharyngodon Bleeker*

11. *Amblypharyngodon microlepis* (Bleeker)

12. *A. mola* (Hamilton)

Genus: *Esomus* Swainson

13. *Esomus danricus* (Hamilton)

Genus: *Barilius* Hamilton

14. *Barilius bendelisis bendelisis* (Hamilton)

15. *B. bola* (Hamilton)

16. *B. vagra vagra* (Hamilton)

Genus: *Rasbora* Bleeker

17. *Rasbora (Rasbora) daniconius* (Hamilton)

18. *R. (Megarasbora) elanga* (Hamilton)

Genus: *Danio* Hamilton

19*Danio (Danio) devario* (Hamilton)

20. *D. (Brachydanio) rerio* (Hamilton)

Subfamily: Cyprininae

Genus: *Catla* Valenciennes

21.*Catla catla* (Hamilton)

Genus: *Ctenopharyngodon* Steindachner

22. *Ctenopharyngodon idella* (Valenciennes)

Genus: *Tor* Gray

23. *Tor putitora* (Hamilton)

24. *T. tor* (Hamilton)

Genus: *Labeo* Cuvier

25. *Labeo angra* (Hamilton)

26. *L. bata* (Hamilton)

27. *L. boga* (Hamilton)

28. *L. boggut* (Sykes)

29. *L.calbasu* (Hamilton)

*30. *L. dussumieri* (Valenciennes)

31. *L. fimbriatus* (Bloch)

32. *L. gonius* (Hamilton)

33. *L. pangusia* (Hamilton)

*34. *L. potail* (Sykes)

35. *L. rohita* (Hamilton)

Genus: *Osteobrama* Heckel

36. *Osteobrama cotio cotio* (Hamilton)

Genus: *Cyprinus* Linnaeus

37. *Cyprinus carpio communis* Linnaeus

38. *C. carpio specularis* Lacépède

Genus: *Cirrhinus* Oken

39. *Cirrhinus mrigala* (Hamilton)

40. *C. reba* (Hamilton)

Genus: *Puntius* Hamilton

41. *Puntius amphibius* (Valenciennes)

42. *P. chola* (Hamilton)

43. *P. chrysopterus* (McClelland)

44. *P.conchonius* (Hamilton)

*45. *P. parrah* Day

46. *P. sarana sarana* (Hamilton)

47. *P. sophore* (Hamilton)

48. *P. terio* (Hamilton)

49. *P. ticto ticto (Hamilation)*

Subfamily : Garrinae

Genus: *Garra* Hamilton

50. *Garra gotyla gotyla* (Gray)

51. *Garra lamta* Hamilton

Genus: *Crossocheilus* van Hasselt
*52. *Crossocheilus latius punjabensis* Mukerjii

Family: PSILORHYNCHIDAE
Genus: *Psilorhynchus* McClelland

*53. *Psilorhynchus balitora* (Hamilton)

Family: COBITIDAE
Subfamily: Noemacheilinae
Genus: *Noemacheilus* van Hasselt

54. *Noemacheilus botia botia* (Hamilton)

*55. *N. corica* (Hamilton)

Subfamily: Botinae
Genus: *Botia* Gray

*56. *Botia (Botia) birdi* Chaudhuri

Subfamily: Cobitinae
Genus: *Lepidocephalus* Bleeker
57. *Lepidocephalus (Lepidocephalichthys) guntea* (Hamilton)
Order: Siluriformes
Family: SILURIDAE
Genus: *Wallago* Bleeker

58. *Wallago attu* (Schneider)

Genus: *Ompok* Lacépède

59. *Ompok bimaculatus* (Bloch)

Family: CLARIIDAE
Genus: *Clarias* Scopoli

60. *Clarias batrachus* (Linnaeus)

Family: HETEROPNEUSTIDAE
Genus: *Heteropneustes* Müller

61. *Heteropneustes fossilis* (Bloch)

Family: AMBLYCIPITIDAE
Genus: *Amblyceps* Blyth

*62. *Amblyceps mangois* (Hamilton)

Family: SISORIDAE
Genus: *Glyptothorax* Blyth

*63. *Glyptothorax telchitta telchitta* (Hamilton)

Genus: *Bagarius* Bleeker

64. *Bagarius bagarius* (Hamilton)

Genus: *Nangra* Day

65. *Nangra nangra* (Hamilton)

Genus: *Gagata* Bleeker

*66. *Gagata cenia* (Hamilton)

Family: SCHILBEIDAE
Subfamily: Schilbeinae
Genus: *Clupisoma* Swainson

67. *Clupisoma garua* (Hamilton)

Genus: *Entropiichthys Bleeker*

68. *Eutropiichthys vacha* (Hamilton)

Subfamily: Ailinae
Genus: *Ailia* Gray

69. *Ailia coila* (Hamilton)

Family: BAGRIDAE
Genus: *Rita* Bleeker

70. *Rita rita* (Hamilton)

Genus: *Mystus* Scopoli

71. *Mystus bleekeri* (Day)

72. *M. cavasius* (Hamilton)

73. *M. vittatus* (Bloch)

Genus : *Aorichthys* Wu

74. *Aorichthys aor* (Hamilton)

75. *A. seenghala* (Sykes)

Superorder: Atherinomorpha
Order: Atheriniformes
Family: BELONIDAE
Genus: *Xenentodon* Regan

76. *Xenentodon cancila* (Hamilton)

Family: POECILIDAE
Genus: *Gambusia* Poey

77. *Gambusia affinis patruelis* (Baird and Girard)

Superorder: Acanthopterygii
Order: Channiformes
Family: CHANNIDAE
Genus: *Channa* Scopoli

78. *Channa gachua* Hamilton
syn. *C. orientalis* (Schn.) according to Hora and Mukerjii (1934) and Jayaram (1981).

79. *C. punctatus* (Bloch)

80. *C. marulius* Hamilton

81. *C. striatus* (Bloch)

Order: Perciformes
Family: GOBIDAE
Subfamily: Gobinae
Genus: *Acentrogobius* Bleeker

*82. *Acentrogobius viridipunctatus* (Valenciennes)

Genus: *Glossogobius* Gill

83. *Glossogobius giuris giuris* (Hamilton)

Family: BELONTIDAE
Subfamily: Trichogasterinae
Genus: *Colisa* Cuvier

84. *Colisa fasciata* (Schneider)

85. *C. lilius* (Hamilton)

Family: MUGILIDAE
Genus: *Mugil* Linnaeus

86. *Mugil cephalus* Linnaeus

Genus: *Liza* Jordan and Swain

*87. *Liza parsia* (Hamilton)

Genus: *Rhinomugil* Gill

88. *Rhinomugil corsula* (Hamilton)

Family: NANDIDAE
Genus: *Nandus* Valenciennes

89. *Nandus nandus* (Hamilton)

Family: CHANDIDAE
Genus: *Chanda* Hamilton

90. *Chanda baculis* (Hamilton)

91. *C. nama* (Hamilton)

92. *C. ranga* (Hamilton)

Order: Mastacembeliformes
Family: MASTACEMBELIDAE
Genus: *Macrognathus* Lacépède

93. *Macrognathus aculeatus* (Bloch)

Genus: *Mastacembelus* Scopoli

94. *Mastacembelus armatus armatus* Lacépède

95. *M. pancalus* (Hamilton)

* New Records

Prior to the present survey, there were some attempts to survey fishes, Mathur (1952), Datta Gupta *et al.*(1961), Dubey and Mehra (1962), Moona (1963), Dhawan(1969), Datta and Majumdar (1970), Mathur and Yazdani (1973), Johal (1982), Johal and Dhillon (1981), Sharma and Johal (1984), Gupta and Kulshreshta (1985), Johal and Sharma (1986), Johal and Chahal (1988) and Ajith Kumar and Vijayan (1988), dealing with different districts, or a water body or a particular fish species. Zoogeography of the fishes of Rajasthan has been discussed by Hora and Mathur (1952).

During the last three decades, due to the implementation of several projects, e.g. irrigation canals (especially in the northwestern part), construction of barrages on the rivers, drastic ecological changes (e.g. appearance of water-logged areas along the river banks, formation of cess-pools along the sides of the irrigation canals) have taken place, affecting the ichthyofaunal composition.

Out of fifteen newly reported species, nine species namely, *Chela (Chela) cachius, Salmostoma phulo punjabensis, Crossocheilus latius punjabensis, Psislorhynchus balitora, Noemacheilus corica, Botia (Botia) birdi, Amblyceps mangois, Gagata cenia* and *Glyptothorax telchitta telchitta* occur in the Indus river system. The northwestern part of the State is at present receiving water supply through irrigation canals from the Indus river system and the end point of the river Ghagger. Therefore, most of the fishes of the Himalayan range have invaded the northwestern part of Rajasthan. Considering the occurrence of the above species in the northwestern part, it is inferred that as the water of Indus river system (rivers Beas and Sutlej) will be supplied to the interior of "Thar Desert", the fish fauna of the Himalayan range will make its appearance.

Two species of the genus *Labeo,* namely *L. dussumieri* and *L. potail* inhabitat of western part of India. Their occurrence may be either due to close proximity of the region or introduction by man. *L. dussumieri* has been reported from Punjab waters by Johal and Tandon (1979, 1980). More or less similar explanation can be given for the occurrence of *Puntius parrah, Liza parsia* and *Acentrogobius viridipunctatus.*

Salmostoma phulo orissaensis has been collected from Jaisamund Lake, Udaipur. It has been reported earlier by Banarescu (1968) from the lower reaches of Mahanadi river in Orissa. As these two localities are widely separated therefore the occurrence of this species can be correlated with the flow of water from east to west during the Pleistocene period (pre-tilt period) as described by Menon (1951).

From the earlier published data, it is concluded that 18 fish species have disappeared. Species like *Labeo dyocheilus, L.nigripinnis, Chagunius chagunio, Barilius barila, B.barna, Garra mullya, Botia (Botia) lohachata, Silondia silondia* have disappeared due to changed ecological conditions, as most of them are inhabitants of clear and unpolluted waters.

Earlier workers have reported some fishes which occur in South India or eastern part of India or Gujarat coast, e.g. *Puntius dorsalis, P.vittatus, Salmostoma clupeoides, Danio aequipinnatus, Noemacheilus denisonii, Aplocheilus lineatus* and *Aphanius dispar*. Their occurrence in the State was accidental or they might have been introduced by some agency for some specific purpose.

A few species, e.g. *Rita pavimentata Silundia gangetica* , *Haplocheilus lineatus* (Datta Gupta *et al.* 1961) and *Aplocheilus blochii* (Mathur and Yazdani 1973) reported earlier do not appear in the list of freshwater fishes of India (Jayaram 1981) and may be considered as not established species.

Datta and Majumdar (1970) and Mathur and Yazdani (1970) reported two new species, namely *Labeo rajasthanicus* and *Noemacheilus rajasthanicus* from Jaisamund Lake and Partap Sagar, Jodhpur respectively. According to them *L. rajasthanicus* closely resembled *L.boggut* and *N.rajasthanicus* with that of *N. denisonii.* These species have not been listed by subsequent workers except Mathur and Yazdani (1973). It is opined that these may be abnormal specimens of closely related species or hybrids.

Osphronemus goramy is an introduced species (Jayaram 1981) for culture purpose in small ponds. It has been replaced by common carp *Cyprinus carpio.*

The occurrence of *Tor khudree* in Rajasthan waters (Mathur 1952, Datta Gupta *el al.* 1961, Dhawan 1969, Datta and Majumdar 1970) is interesting. According to Jhingran and Sehgal (1978), this species occurs in Tamil Nadu and Kerala, however Jhingran (1991) is of the view that it occurs in Orissa and Peninsular India, especially Karnataka, Kerala and Maharashtra hill streams. Moreover the zoogeographical limits of different species of the genus *Tor* Gray are very restricted and their transplantations outside their distributional limits are not successful.

Some species reported earlier have been synonymised, e.g. *Puntius stoliczkanus* with *P. ticto; P. tetrarupagus* with *P. chola; P. stigma* with *P. sophore* and *Labeo microphthalmus* with *L.dero* (Menon 1974, Jayaram 1981).

It may be concluded that due to increased flow of water of Indus river system to Thar Desert, and with the completion of lift canal in Bikaner division and its various distributaries, the fish fauna of Western Himalayas and Aravallis may intermingle in the near future.

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STUDIES ON THE HYPERPARASITES OF *DIAPHANIA INDICA* (LEPIDOPTERA: PYRALIDAE) THROUGH *APANTELES TARAGAMAE* (HYMENOPTERA: BRACONIDAE)[1]

Clement Peter and B.V. David[2]

(With a text-figure)

Key words : *Diaphania indica, Apanteles taragamae,* hyperparasites

Six hyperparasites of *Diaphania indica* were reared through *Apanteles taragamae.* These were *Stictopisthus srinaraini, Aphanogmus fijiensis, Eurytoma braconidis, Elasmus brevicornis, Brachymeria apantelesi* and *Tetrastichus pantnagarensis.* These hyperparasites constitute new records for *A. taragamae.* It was estimated that 55.43% of *A. taragamae* cocoons were parasitised by these six species of hyperparasites thus severely restraining the biocontrol potential of this primary parasite.

Introduction

Apanteles taragamae is a gregarious endoparasite and was described by Viereck in 1912 from specimens reared from *Taragamae dorsalis* Moore. It was recorded from *Diaphania indica* on snakegourd for the first time from Sri Lanka (Wilkinson 1931). In 1948, Bhatnagar listed the following as hosts of *A. taragamae* in India : a) *Taragama dorsalis* Moore; b) *Autographa peponis* Fab.; c) *Homona coffearia* Nietner; d) *Nephantis serinopa* Meyrick; e) *Diaphania indica* (Saunders); f) *Grapholitha molesta* Busck; g) *Bocchoris artificialis* Led.; h) *Diacrisia obliqua* Walker; i) *Laspeyresia* sp.; j) *Eucosoma critica* Meyrick; k) *Cirphis unipunctata* Howarth; l) *Laspeyresia tricentra* Meyr; m) *Hyblaea puera* Cram.

During the studies on natural enemies of *D.indica* it was observed that *A.taragamae* was the major parasite. Even though parasitism of *D.indica* during certain seasons was as high as 80%, the pest was not completely controlled in the field and it was suspected that hyperparasites may be responsible for suppressing the action of this primary parasite to some extent. Hyperparasitism is defined as any form of parasitism other than primary (Smith 1916). There is disagreement over the importance of hyperparasitism to biological control (Narayanan 1957, Flanders 1963, Valentine 1974) but it generally is conceded that the identification of hyperparasites is supremely important to biological control. Hence in the present study an intensive survey was carried out to determine the hyperparasites attacking *A. taragamae* and also the relative extent of suppression it exercises on the role of this primary parasite.

Materials and Methods

This study was carried out at the research farm of the Fredrick Institute of Plant Protection and Toxicology. *Coccinia grandis; Momordica charantia, Trichosanthes anguina* and *Cucumis sativus* were maintained under unsprayed conditions for this purpose. Cocoons of *A. taragamae* were collected from the various crops at weekly intervals and enclosed separately in glass specimen tubes. This was kept under observation in the insectary until the primary parasite *(A. taragamae)* or the hyperparasite emerged.

This procedure was carried out for one year from January to December 1986. At the end of this period a total of 266 *A.taragamae* cocoons were collected from the field and held in the laboratory. The number of parasitised cocoons as well as the type of hyperparasites emerging were recorded. The

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hyperparasites were identified and voucher specimens deposited in the reference collection of the Department of Entomology, Fredrick Institute of Plant Protection and Toxicology.

RESULTS AND DISCUSSION

The study carried out to determine the hyperparasites of *D. indica* occurring through *A. taragamae* revealed that this primary parasite was attacked by the following six secondary parasites:

1. *Stictopisthus srinaraini* Gupta (Ichneumonidae: Hymenoptera)
2. *Aphanogmus fijiensis* (Ferriere) (Ceraphronidae: Hymenoptera)
3. *Eurytoma braconidis* Ferriere (Eurytomidae: Hymenoptera)
4. *Elasmus brevicornis* Gahan (Elasmidae: Hymenoptera)
5. *Brachymeria apantelesi* Risbec (Chalcididae: Hymenoptera)
6. *Tetrastichus pantnagarensis* Khan (Eulophidae: Hymenoptera)

Of these six hyperparasites, *S. srinaraini* attacked the parasitised larvae of *D. indica*. The eggs were laid in the larva of *D. indica* in the field and the hyperparasite adults emerged from the laboratory held *Apanteles* cocoons. Only one parasite emerged from each cocoon of *A. taragamae*. The number of *S. srinaraini* adults emerging from each cocoon mass ranged from 2-7 (average - 5.71). The other five hyperparasites, namely *A. fijiensis, E. braconidis, E. brevicornis* and *B. apantelesi* were pupal parasites. The cocoons of *A. taragamae* were parasitised and the hyperparasites emerged from these cocoons held in the laboratory. Ramachandra Rao *et al.* (1948) reported *Calliceras manilae* Ashm., *Eurytoma albotibialis* Ashm., *Perilampus microgastris* Ferr. and *Brachymeria nephantidis* as hyperparasites of *Opisina arenosella* through *A. taragamae*. Subsequently, Ghosh and Abdurahiman(1985) recorded *Pediobius imbreus* and *Eurytoma braconidis* as hyperparasites of *Opisina arenosella* through *A. taragamae*. But both these workers have reported *A. taragamae* as a solitary parasite, while Nixon (1965) has indicated that *A. taragamae* is a gregarious parasite, making white, papery cocoons, loosely heaped together.

In the light of this observation it is quite clear that the earlier record of hyperparasites of *A. taragamae* were erroneous. It was probably reared from some other solitary *Apanteles* sp. parasitising *O. arenosella* and not through *A. taragamae* which is a gregarious parasite. Hence, the present report of these hyperparasites through *A. taragamae* constitutes new records. A literature search on these hyperparasites listed above has revealed the following records:

Stictopisthus srinaraini Gupta was originally described as a secondary parasite of *A. ruficrus* (Gupta 1957). In this study, it was observed that it attacked the phytophagous host of the primary parasite and it developed on it within the host larva. This species is a typical example of indirect secondary parasitism (Flanders 1963).

Aphanogmus fijiensis (Ferriere) was originally described as *Calliceras fijiensis* as a hyperparasite of *Tirathaba* sp. through *Apanteles tirathabae* Wlk. (Ferriere 1933). It has also been recorded as a hyperparasite of *Microgaster curticonis* Granger (Williams 1951). Later, it was reported as a parasite of *Cremastus (Trathala) flavo-orbitalis* (Cameron) in Fiji (Hinckley 1963). *Ceraphron* sp. near *fijiensis* was also recorded as a hyperparasite of the coconut pest, *Artona catoxantha* Hampson through *Apanteles artonae* Roh. from Malaya (Lever 1964).

Eurytoma braconidis was originally described as a hyperparasite of *Platyedra* sp. through *Microbracon hancocki* (Ferriere 1929). *E. braconidis* has been previously reported as a hyperparasite of

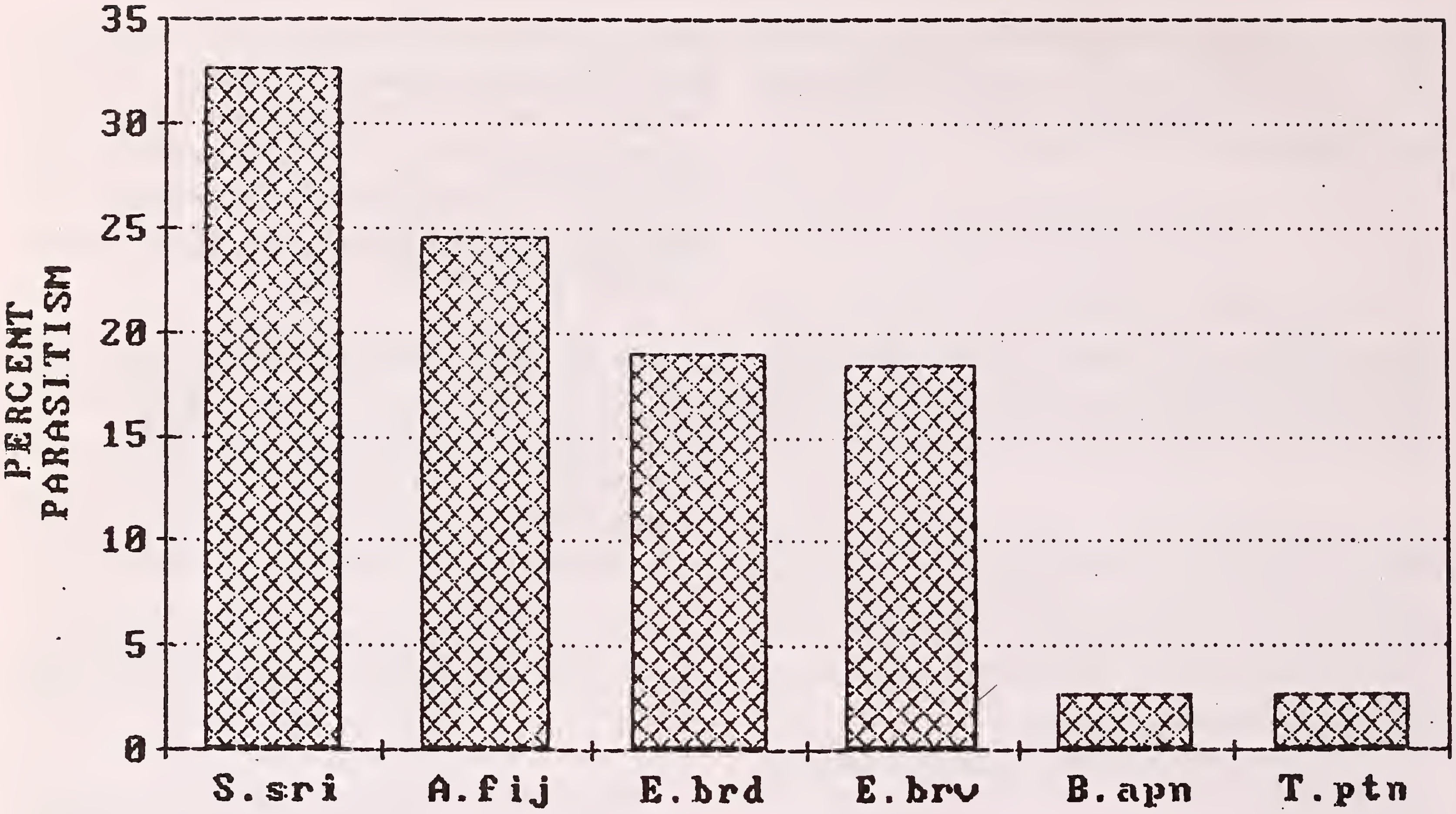

Fig. 1. Relative parasitism of *Apanteles taragamae* by six species of hyperparasites.

Sylepta derogata through *Apanteles sylepta* (Thompson 1953).

Elasmus brevicornis Gahan was first described as a primary parasite of *Erionota thrax* Linn. (Ferriere 1929). *E. brevicornis* has earlier been recorded as a primary parasite of *Eutectona machaeralis, Pasara stultalis* Wlk. and *Sylepta derogata* F. (Thompson 1953). Among the hyperparasites associated with *A. taragamae*, it was observed that *E. brevicornis* was the only hyperparasite operating in the facultative capacity. It has been earlier recorded as a hyperparasite of *Eutectona machaeralis* through *Apanteles machaeralis* (Thompson 1953). In the present study, it was recorded both as a primary as well as hyperparasite of *D. indica*.

Brachymeria apantelesi Risbec. has earlier been reported as a hyperparasite of *Diacrisia scortilla* Wallengrin through *Apanteles aethiopicus* Wilkinson and *A. procerae* (Thompson 1953).

The results of the study conducted during 1986 to assess the relative degree of hyperparasitism by the six species is summarised in Table 1. The study revealed that 55.43% of the *A. taragamae* cocoons collected from the field were parasitised and of the six hyperparasites, *Stictopisthus srinaraini* was the most abundant species (18.11%) followed by *Aphanogmus fijiensis* (13.58%), *Eurytoma braconidis* (10.56%), *Elasmus brevicornis* (10.18%), *Brachymeria apantelesi* (1.50%), *Tatrastichus pantnagarensis* (1.50%). This corresponds to 32.64, 24.48, 19.04, 18.36, 2.72 and 2.72% of the total parasitism by these six species, respectively (Fig 1).

The action of hyperparasites in restraining the biocontrol potential of parasites particularly in classical biological control attempts is well known (Flanders 1943, Doutt and DeBach 1964, Van Den Bosch and Messenger 1973). Muesbeck and Dohanian (1927) states that "hyperparasites have

Table 1

RELATIVE PARASITISM OF *A. TARAGAMAE* BY THE SIX SPECIES OF HYPERPARASITES OUT OF THE TOTAL 266 FIELD COLLECTED COCOON MASSES FROM JANUARY TO DECEMBER 1986

Hyperparasite	No. Parasitised	% from genus	% of six hyperparasites
S. srinaraini	48	18.11	32.67
A.fijiensis	36	13.58	24.49
E.braconidis	28	10.56	19.04
E.brevicornis	27	10.18	18.36
B. apantelesi	4	1.50	2.72
T. pantnagarensis	4	1.50	2.72
Total	147	55.43	100

often seriously interfered with the progress of the studies in the biological control of injurious insect species and with the institution of this method of control on a practical basis". They state further that a primary parasite introduced for the purpose of biological control may be overwhelmed by hyperparasites before it can succeed in firmly establishing itself. Thus, most experienced biological control workers believe that hyperparasites are deleterious, based on the assumption that since hyperparasites possess attributes similar to those which make a primary parasite an effective biological control agent, they can regulate a primary parasite population. It is evident from this study that hyperparasites play a dominant role in suppressing the biocontrol potential of *A. taragamae* which is the major parasite of *D. indica*.

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OCCURRENCE OF *ARHODEOPORUS BONAIRENSIS* (VIETS, 1936) (HALACARIDAE: ACARI) FROM INDIAN OCEAN WITH ZOOGEOGRAPHICAL REMARKS ON GENUS *ARHODEOPORUS* NEWELL[1]

A.L.N. Sarma and Tapas Chatterjee[2]

(With eight text-figures)

KEY WORDS : ZOOGEOGRAPHY, HALACARIDAE, ACARI, INDIAN OCEAN, ECOLOGY

Arhodeoporus bonairensis (Viets, 1936) is reported for the first time not only along the Indian coast but also from the Indian Ocean. A brief description including the classification, synonymy along with zoogeographic and ecological remarks on the genus and its species is provided.

Marine halacarids received little attention and almost remained undocumented in the faunistic surveys and researches conducted along the Indian Coast. About 700 species of halacarids are known to science from different world oceans. Of these as many as 67 (9.57%) named species are known from the Indian ocean and eight along the Indian Coast. Recently, Sarma and Chatterjee (1991 b, 1993) and Chatterjee (1991 a, b) recorded four species from Indian seas. In view of the paucity of information on the bio-diversity of halacarids along the Indian coast, a detailed comprehensive ecofaunistic study of halacarids from diverse marine littoral environs is being undertaken by us. The taxonomic studies yielded a rich crop of species and would be described elsewhere. Presently, the occurrence of *Arhodeoporus bonairensis* (Viets 1936) is reported here for the first time not only along the Indian coast but also from the Indian ocean. The genus is recorded for the first time from the Indian Coast.

Several specimens including males and females of *Arhodeoporus bonairensis* (Viets 1936) were seen among the littoral algal tufts of *Halimeda opuntia* from Chiriatapu Island, Port Blair (Andaman Islands), Muss Island, Nicobar Island (Bay of Bengal), *Gracilaria corticata* from Kovalam beach, Kerala Coast and *Spongomorpha* sp. from Goa (Arabian Sea). *A.bonairensis* is so far known only from Bonaris (Viets 1936) (type locality), east coast of North America (Newell 1947) (Atlantic Ocean) and Galapagos (Bartsch 1977a) (Eastern Pacific Ocean). Out of the 16 named species and three undetermined species of the genus *Arhodeoporus,* four species (including the present one are known from the Indian Ocean, and the rest from Atlantic and Pacific Oceans (Table 1). A brief description including classification synonymy and relevant illustrations of the species is given alongwith remarks on the zoogeography and ecology of the genus.

CLASSIFICATION

Phylum	-	Arthropoda
Class	-	Arachnida
Subclass	-	Acari
Order	-	Acariformes
Suborder	-	Actinedida
Superfamily	-	Halacaroidea
Family	-	HALACARIDAE
Subfamily	-	Halacarinae
Genus	-	*Arhodeoporus*
Species	-	*bonairensis*

SYNONYM: *Copidognathus (Copidognathopsis) bonairensis* Viets, 1936. pp. 391,415; Viets,1940, p. 53; Viets,1956, p. 676. *Copidognathus* (s.str.) *bonairensis* (Viets, 1936); Newell, 1947, pp. 130, 172. *Arhodeoporus bonairensis* (Viets, 1936); Bartsch, 1977, pp. 60-61.

DESCRIPTION

The length of idiosoma of the males ranged

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from 190 μ to 221 μ and of the females 208 μ to 216 μ. All the dorsal plates are separate (fig.1). Anterior and posterior areolae on Antero-dorsal plate (AD) are fused in the form of an inverted goblet-like structure in the females (fig. 4) while, males nearly approximate the conditions (figs. 5,6). Ocular plate (OC) bears anteriorly two corneae and is posteriorly drawn into a caudiform process extending beyond the insertion of leg III. Postero-dorsal plate (PD) with 4 costae made up of porose panels. All the ventral plates are fused (figs.2,3) and sculptured with distinct clusters of pores forming porose panels. Tibiae I-II with 4 ventral setae (figs. 7, 8). Genital opening (GO) of female bears 2 pairs of subgenital setae (SGS).

The specimens in general match well with the available figures and description of the species (Viets 1936, Newell 1947, Bartsch 1977a). Bartsch (1977a) observed no fusion of the anterior and posterior areolae of AD in the case of males collected from Galapagos in eastern Pacific Ocean. But in the males collected by us the anterior and posterior areolae are closely oriented, almost approximating a goblet shape. However, the posterior areolae in the males are seen to be relatively less broad comprising of a few porose panels. Anteriorly, at the point of fusion with the neck of the goblet, the porose sculpture of the posterior areolae is feebly developed or absent in the male (figs. 5,6). Intensive study of the species from different geographical regions would resolve the variability of this trait. Sexual dimorphism among the males and females in the display of ventral plates is not observed as these are fused in both the sexes (Figs. 2 and 3).

Regarding the zoogeography and ecology of the distribution patterns of the genus *Arhodeoporus* and its species, Newell (1984) observed three significant facts: i) The genus is cosmopolitan in distribution although none of its species are. ii) The genus is represented by deep water forms in probably all oceans. iii) Species of this genus have invaded intertidal habitats only in the North Atlantic. Further, he states ".....the genus may be a better representative in the subtidal zone rather than in the intertidal in the North Atlantic. This is definitely true in the rest of the world.... In the intertidal, it is basically an interstitial group".

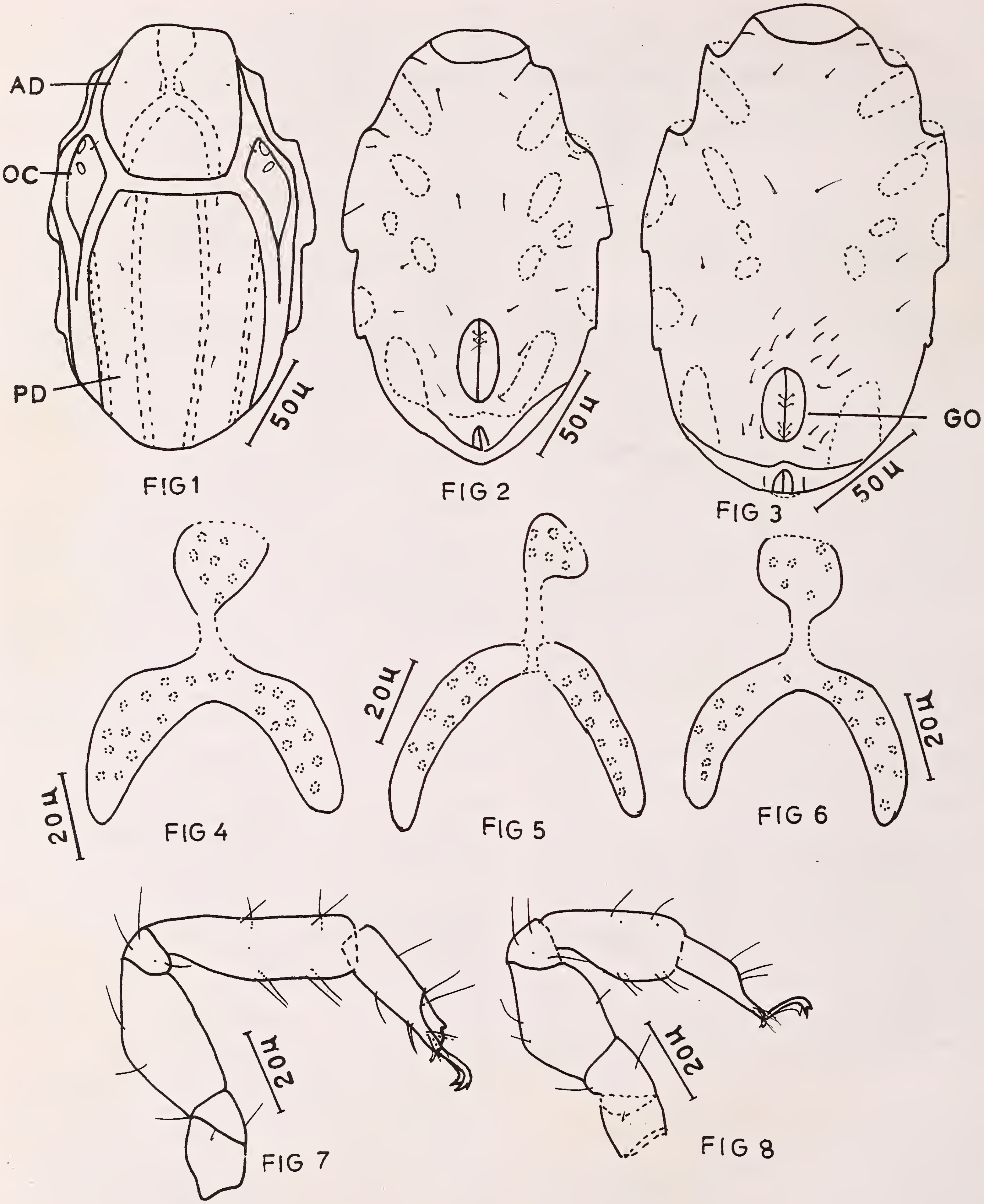
A perusal of Table 1 shows that as many as 37% of the total species of the genus are known from intertidal, upper subtidal and shallow water environments. As such, the predominantly subtidal deepwater inhabitation of the genus as advocated by Newell (1984) may have to be accepted with reservation. Newell (1984) opined that the intertidal invasion by *Arhodeoporus* in North Atlantic basin might have been caused by "...the evolution of forms preadapted to intertidal life in the North Atlantic or from diminished competitive pressures in the intertidal fauna of this relatively new ocean or both." The present find from the tropical intertidal algal thalli in the Indian Ocean, one of the oldest oceanic basins with the most severe competitive pressures in the tidal zone making it difficult for the alien subtidal forms to populate, tends to cast doubt on the invasion or migration of *Arhodeoporus* from deepwater to the foreshore or being endowed with preadaptations for a successful colonisation. Perhaps, the possibility of the converse of the suggested invasions may also deserve attention. Bartsch (1988), while acknowledging *Arhodeoporus* probably as an exclusively shallow water genus considered those mites collected from depths more than 1000 m as deep-sea forms and those from less than 1000 m as shallow water forms. This appears to associate an extend bathymetric limit for shallow waters which otherwise connote, at best, up to the continental shelf (Sverduet *et al*. 1961).

Likewise, the predominantly interstitial nature of the genus, between the tide marks, is to be taken with caution, since species of the genus are known from salt marshes, intertidal sands, algal bands, coral mounds, hydrozoan and bryozoan colonies

TABLE 1

WORLD DISTRIBUTION OF GENUS *ARHODEOPORUS* AND ITS SPECIES

Sl No. 1	Species 2	Author (Major Ref.) 3	Biota 4	Place 5
1.	*Arhodeoporus arenarius* Newell, 1947	Newell 1947, Bartsch 1980, 1982a	Intertidal and subtidal Algae, sand, Broken shell,Sponge, Hydrozoa.	North America.
2.	*A. bonairensis* (Viets, 1936)	Viets 1936,Newell 1947, Bartsch 1977, Present report	Intertidal, upper subtidal, Interstitial sands, Intertidal algae.	Bonaire, Florida, Galapagos. A & N Island, Kovalam,Goa.
3.	*A. brevocularis* Bartsch, 1973	Bartsch 1973	206 m.	Great Meteor Bank of Eastern North Atlantic.
4.	*A. bucculentus* Bartsch, 1977a	Bartsch 1977a	Intertidal, Interstitial.	Galapagos.
5.	*A. eclogarius* (Andre, 1959)	Andre 1959	Shallow water.	Gulf of Suez.
6.	*A. gracilipes* Thouessart, 1889	Major reference: up to 1956 - Viets1956, Bartsch 1977b.	Intertidal to depth down to 1410 m interstitial, seagrass algae.	Norway (Thomso), North Sea, French, Atlantic Coast, Mediterranea, Black Sea.Wales, Ireland. Azores, Senegal, England,
7.	*A. kunzi*, Bartsch, 1987	Bartsch 1987	—	South coast of Africa.
8.	*A. lineatus* Bartsch, 1973	Bartsch 1973	301-530 m depth.	Great Meteor Bank of Eastern North Atlantic.
9.	*A. longirostris* Bartsch, 1981	Bartsch 1981	26-440 m	Mozambique Channel.
10.	*A. mammillifer* Newell,1971	Newell 1971	160 m	Anton Bruun Sta.,South Eastern Pacific Ocean.
11.	*A. mirabilis* Bartsch,1982b	Bartsch 1982b	15 m depth.	Gulf of Hondorus.
12.	*A. minor* Bartsch, 1977b	Bartsch 1977b	—	Brittany.
13.	*A. perlucidus* Bartsch,1982b	Bartsch 1982b	Pond/pool, cave water.	Bermuda.
14.	*A. tessellatus* Morselli and Mari, 1981	Morselli and Mari 1981	Shallow subtidal sandy bottom.	Italy coast.
15.	*A. thyureophorus* (Andre, 1959)	Andre 1959	27 m	Gulf of Suez.
16.	*A. submarinus* Newell,1947	Newell 1947, Bartsch 1982a	34 m	Rhode Island, North America
17.	*Arhodeoporus* sp. A Bartsch, 1982b	Bartsch 1982b	—	Philippines.
18.	*Arhodeoporus* sp. B Bartsch, 1982b	Bartsch 1982b	—	West Coast of South Africa.
19.	*Arhodeoporus* sp. C. Bartsch, 1982 b	Bartsch 1982b	—	Philippines.


AD
OC
PD
GO
50µ
50µ
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20µ
20µ
20µ
20µ
20µ

FIG 1 FIG 2 FIG 3

FIG 4 FIG 5 FIG 6

FIG 7 FIG 8

Fig. 1. Idiosoma dorsal (female); Fig. 2. Indiosoma ventral (female) ; Fig. 3. Idiosoma ventral (male); Fig. 4. Areolae of AD (female) ; Figs.5-6. Areolae of AD (male) ; Fig. 7. Leg I; Fig. 8. Leg II.

(Table 1).

Bartsch (1982b) is of the view that the land barriers and the intervening vast expanses of water masses which affected the once widely distributed Tethys fauna might be responsible for the present distribution patterns of the species of the genus *Arhodeoporus*. On the geographical distribution of interstitial fauna of marine beach sands, Rao (1972) stated endemism and the absence of identical interstitial species in the intertidal sands all over the world might have positively resulted due to lack of intensive faunistic survey in different parts of the world besides recessions and extinctions leaving behind the present species as relicts. Thus the present discontinuity of the species may be a secondary condition derived from a primary continuity. This view finds further substantiation in the fact that the bivalved gastropods of the taxa *Berthelinia* and *Julia* known today throughout the Atlantic, Pacific and Indian Oceans (Ganapati and Sarma 1972, Sarma 1975, Sarma and Chatterjee 1991a) were once thought to have puzzling discontinuous distribution (Keen and Smith 1961, Kay 1968). This discontinuity was mainly due to lack of intensive faunistic researches.

It can, therefore, be reasonably assumed that with increasing systematic researches, many species of the genus *Arhodeoporus* may eventually turn out to have extended zoogeographic distribution as is the case with the species under report.

ACKNOWLEDGEMENTS

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IDENTIFICATION OF SOME PLANTS FROM 'HORTUS MALABARICUS'[1]

M.R. Almeida and S. M. Almeida[2]

(With three plates)

Key words: nomenclatural changes, *Leucostegia alternifrons, Ehretia indica, Actinodaphne quinqueflora, Embelia drupacea, Quirivelia frutescens, Chonemorpha grandiflora, Parsonsia inodora*

The paper deals with the nomenclature of 6 plants of which one is a fern and the rest are flowering plants. The correct Scientific names of the plants have been brought out and thus 6 new combinations have been established.

Hendrik Andrian van Draakenstein van Rheede (1678-93) published 12 volumes of 'Hortus Malabaricus' comprising descriptions and figures of more than 780 species of vascular plants. About 250 figures from Rheede's work were cited under various species by Linnaeus (1753) in his pioneering work on the binomial system of plant names. Since then, various authors have tried to interpret and identify plants described and figured by Rheede. Major commentaries were written on this monumental work by Dennstedt (1818), Dillwyn (1839), Hasskarl (1867), Buchanan-Hamilton (1822-1835) etc. The latest comprehensive work on entire interpretation of Rheede's work has been published by Nicolson *et al.* (1988). This work basically covers the results included in the Ph.D. Thesis undertaken by C.R. Suresh. Dr. Suresh has really worked hard at collecting information and arriving at conclusions. In most of the cases he has succeeded in explaining the identities of Rheede's plants and in the understanding of these species in terms of their modern and correct scientific names. However, a few identifications remain controversial and need reinvestigation.

We have been working on the plants of Maharashtra for the last two decades and 'Hortus Malabaricus' was one of the topics of our interest in the past. We have tried to work out the identities of the plants on the basis of Flora of Maharashtra and have arrived at certain conclusions. We in fact, wanted to continue publication of the facts discovered by us. However we came to know of Suresh's work at Calicut University in collaboration with Smithsonian Institution, Washington. Therefore, we withheld our publications to avoid duplication in the presentation of facts. Inspite of our best efforts, we could not procure Suresh's work earlier and we have been able to see it only in 1992.

As stated earlier, we do have some opinions different to those published by earlier authors including Nicolson *et al.* (1988) and in the following pages we discuss the correct identification of some of the species in 'Hortus Malabaricus' in the light of the plants known to us from Southern India, especially from Maharashtra.

1. **Leucostegia alternifrons** (Dennst.) comb. nov.

Aspidium alternifrons Dennst., Schlussel 11, 19, 39. 1818. *Asplenium alterniforns* (Dennst.) Dillwyn, Rev. Hort. Mal. 64. 1839. *Cheilanthes tenuifolia* sensu Nicolson *et al.,* Interpr. Hort. Malab. 29. 1988 non (Burm. f.) Swartz. *Leucostegia pulchra* Presl., Tent pterid. 94, t. 4. 11. 1836. *Asplenium adiantum - nigrum* sensu Swartz., syn. Fil. 87. 1806 (pro parte excl. type); Datta, Bull. Bot. Surv. Ind. 27: 133. 1985.

'Kal-panna-marvara' (Rheede, Hort. Mal. 12: 33, t. 16. 1693) is identified by Nicolson *et al.* (1988) as *Cheilanthes tenuifolia* (Burm.f.) Sw. in consultation with Dr. B.K. Nair. Rheede reported

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[1] Accepted June , 1992.

[2] Blatter Herbarium, St.Xavier's College, Bombay 400 001.

that this species grows epiphytic on trees and also occurs lithophytic on stones. However, his figure shows a distinct epiphytic habit of the species which has been described.

Dillwyn (1839), followed Swartz (1806) and D. Don (1825) in considering the epiphytic habit of the taxon and placed it in the genus *Asplenium*. Dutta (1985), noticed that Swartz (1806) had quoted Rheede's figure under *Asplenium adiantum-nigrum* L. and identified Rheede's plant as that species. However, on the basis of typification of Linnaeus's species, now it is restricted to North America and is not available in Southern India.

Considering the fact that *Cheilanthes tenuifolia* (Burm.f.) Swartz is never found epiphytic on trees but is always a terrestrial species, we were forced to search for an alternative identity of the species. We had no difficulty in placing this fern, found at Mahabaleshwar, as a species so far known as *Leucostegia immersa* Presl. (1836). It is found epiphytic on trees and lithophytic on laterite stones at Mahabaleshwar. As Rheede's element is the sole basis of *Aspidium alternifrons* Dennst. (1818) which is the earliest name for this species, we propose a new combination under the genus *Leucostegia* Presl. calling it as *Leucostegia alternifrons* (Dennst.) comb. nov.

Genus *Leucostegia* Presl. was established on the species based on *Davallia immersa* Wall. (Cat No. 256, 1826), which is a nomen nudum.

Besides the epiphytic habit, Rheede's species (*Leucostegia alternifrons*) also differs from *Cheilanthes tenuifolia* (Retz.) Swartz in the following characters:

Leucostegia alternifrons	*Cheilanthes tenuifolia*
1.Epiphytic on trees.	Never epiphytic on trees.
2.Roots in Rheede's species decribed as black but stipe is not described as black. It is said to be "Viridi-clavus" meaning it is grass-like or straw-coloured.	Stipe is much darker than roots.
3. Stipes depressed, angular.	Stipes cylindrical.

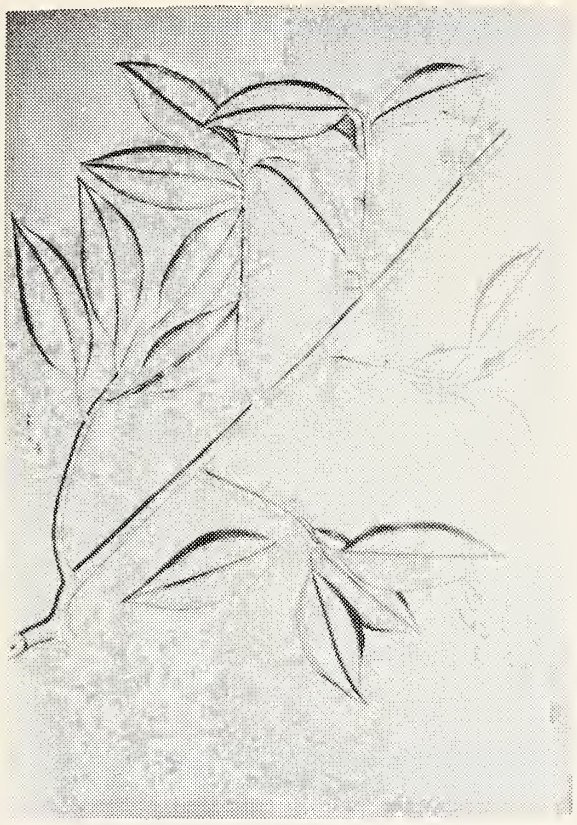
Since the name adopted here is based on *Aspidium alternifrons* Dennst., it is necessary to lectotypify the names. It seems that Rheede has not preserved any original materials of his figures given in Hortus Malabaricus (see Johnston, M.C. 1970). Therefore it is necessary to choose a "Neotype" of the name. A specimen from Mahabaleshwar (M.R. Almeida - 787, BLAT) is selected herein as a 'Neotype' of *Aspidium alternifrons* Dennst.

The figure in Rheede's "Kal-panna-maravara" pertains to a sterile specimen and exactly matches a similar specimen collected by Rev.Fr. Ethelbert Blatter (E. Blatter - A-1, BLAT) from High-Wavy Mountains of Madura (Madurai).

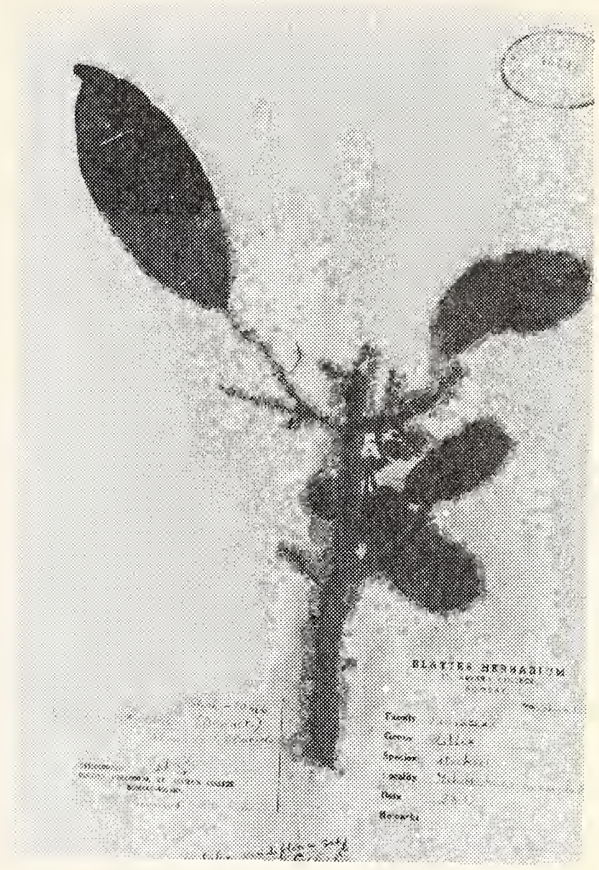
2. **Ehretia indica** (Dennst. ex Kostel) comb. nov.

Bruxanelia indica Dennst. ex Kostel., Allg. Med. Pharm. Fl. 5: 2002. 1836. *Ehretia laevis* Roxb. var. *canarensis* C.B.Clarke, in Hook. f. Fl. Brit. Ind. 4: 142. 1883; Cooke, Fl. Pres. Bombay 2: 203. 1905. *E. canarensis* (Clarke) Gamble, Fl. Pres. Madras 891. 1921. *E. laevis* Wight, Icon. t. 1382. 1848 (non Roxb. 1796); Beddome, Fl. Sylvat. t. 246. 1872.

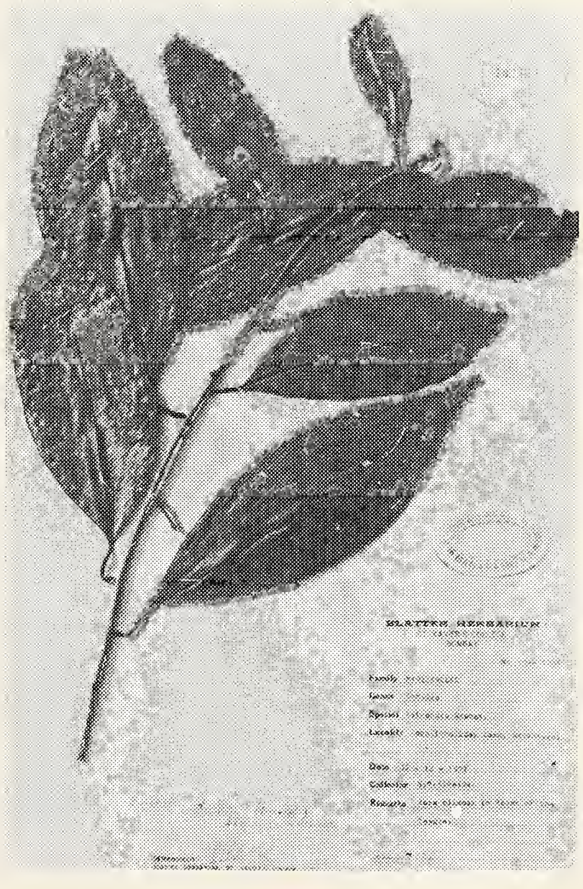
A few years ago, (in J. Bombay nat. Hist. Soc. 83 (suppl.) 224. 1986) we identified "Sundari" of Rheede's Hortus Malabaricus as *Ehretia laevis* Roxb. This identification has been confirmed by Nicolson



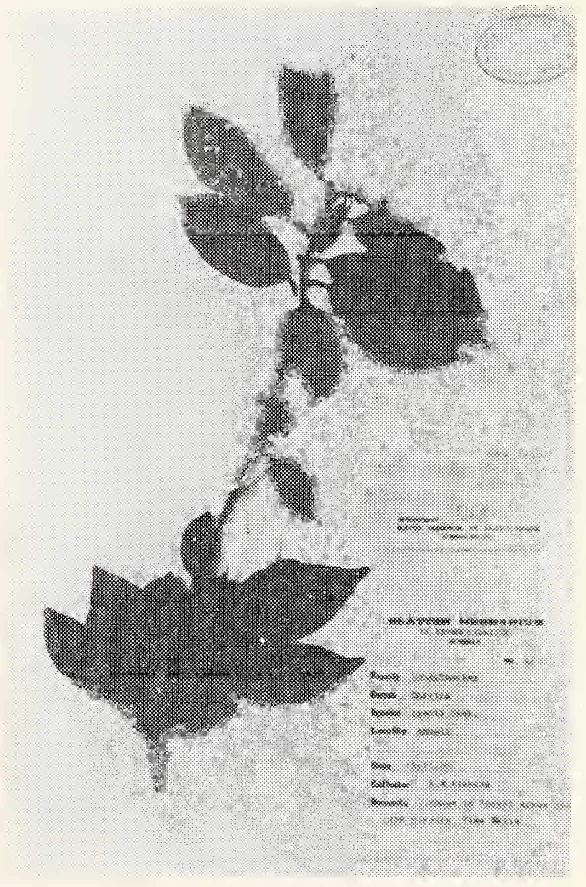
"Pu-valli"



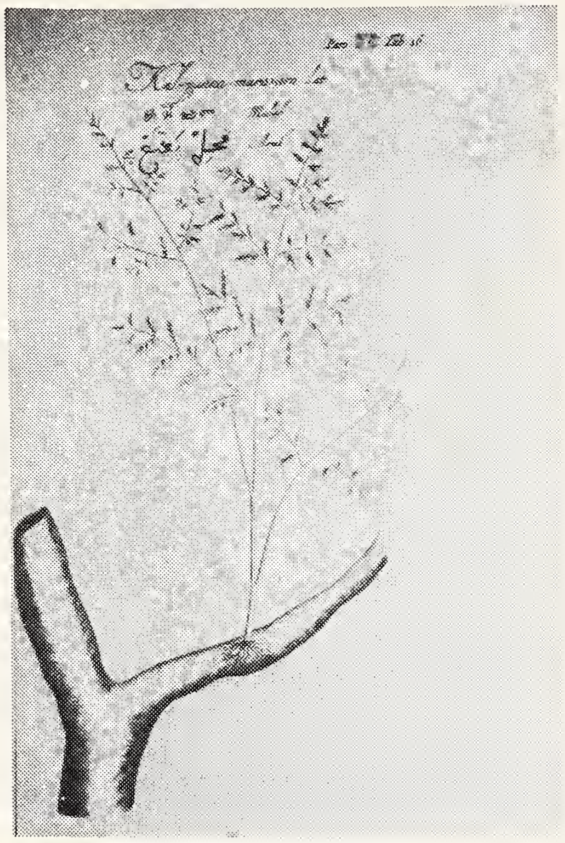
Embelia drupacea (Dennst.) Almeida & Almeida



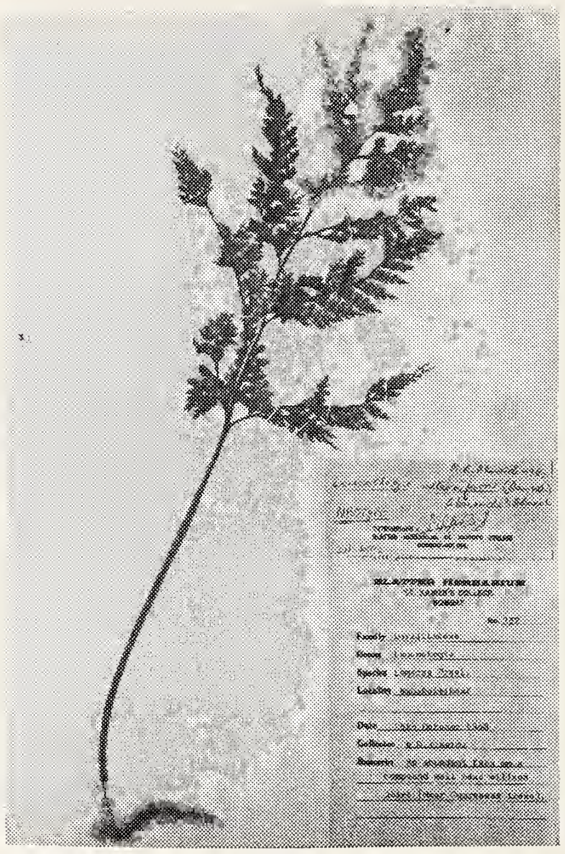
Embelia tetrandra Graham



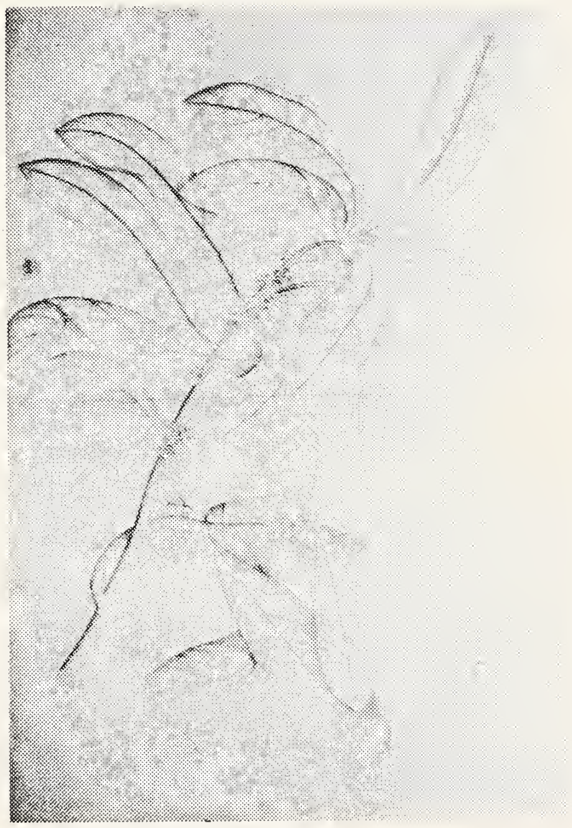
Ehretia indica (Dennst. ex Kostel) Almeida & Almeida



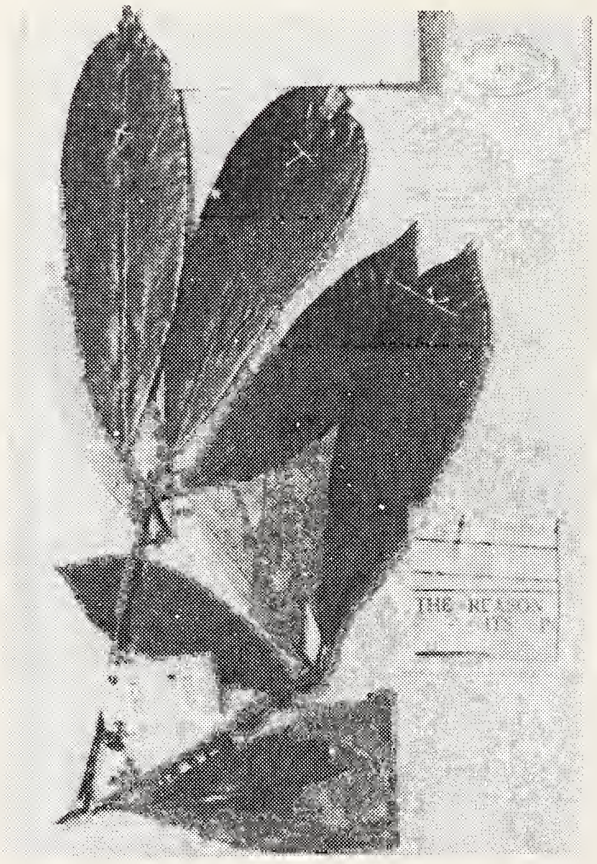
"Kal-panna-marvara"



Leucostegia alternifrons (Dennst.) Almeida & Almeida



"Mala-poenna"



Actinodaphne quinqueflora (Dennst.) Almeida & Almeida *et al.* in their recent book (1988). While working on identity of "Sundari" we had in fact realised that Rheede's other figure "Bruxaneli" (Rheede Hort. Mal. 5: 83-4, t. 42. 1685) was also a related species to that taxon. However, going by Rheede's figure and not paying much attention to Rheede's description of the species we were mislead by the unbranched simple inflorescence shown in the figure.

However, the identification of 'Bruxaneli', by Nicolson *et al.* (1988) as *Blachia denudata* Benth. (Euphorbiaceae), prompted us to thoroughly investigate the identity of this taxon once again.

In our fresh bid to re-establish the correct identity of this species we have realised that we were correct in thinking that "Bruxaneli" was a species of *Ehretia* Linn. In fact, though Rheede's figure shows simple, (unbranched) inflorescence, in the text he mentions it to be "extremis ramulis" meaning that it is extremely branched, clearing all misunderstanding about the unbranched inflorescence. Now we identify 'Bruxaneli' of Rheede as presently known taxon - *Ehretia laevis* Roxb. var. *canarensis* C. B. Clarke.

Although Clarke (1883) considers this taxon a variety of *Ehretia leavis* Roxb. We consider it to be a distinct species as originally construed by Rheede himself. Phytochemically, the plants must be considerably different, because the leaves of *Ehretia indica* turn black on drying while in *Ehretia laevis* they are brown in colour.

Cooke (1905) in *Flora of Presidency of Bombay* is apprehensive about var. *canarensis* being a good reliable variety. Gamble on the contrary raised it to the status of a distinct species. However, *Ehretia laevis* Roxb. and *Ehretia indica* Almeida and Almeida can be distinguished on the following characters:

Ehretia laevis Roxb.	*Ehretia india* Almeida & Almeida
1. Leaves unsymmetric, pale when dry.	1. Leaves symmetric, dark-brown or black when dry.
2. Leaf-base cuneate.	2. Leaf-base attenuate.
3. Leaf surface rusty pubescent.	3. Leaf surface almost glabrous.
4. Fruit orange-scarlet.	4. Fruit black.

The leaf size and shape in this species varies considerably. The apex is very often acute and sometime even acuminate.

This species is very common in the evergreen forests at Amboli and in North Kanara. It is called 'Datrang' at Amboli.

We, hereby designate the specimen from Savantwadi (S.M. Almeida - 3205, BLAT) as a 'Neotype' of the species, since the specimens from original protologue of Rheede are non-existent.

As per the citation of Gamble in Flora of Presidency of Madras, the type of *E. canarensis* (Clarke) Gamble should be the specimen (No.285) in Hohenacker Herbarium.

3. **Actinodaphne quinqueflora** (Dennst.) comb. nov.

Darwinia quinqueflora Dennst., Schlussel 12, 20, 31. 1818. *Litsea quinqueflora* (Dennst.) Suresh, in Nicolson *et al.* Interpret. Hort. Mal. 150. 1988. *Litsea liqustrina* sensu Suresh in Nicolson *et al.* Interpret. Hort. Mal. 158. 1988 (in Synonymy, non Benth. & Hook. 1880).

"Mala-poenna" (Rheede, Hort. Mal. 5: 17, 17-8, t. 9. 1685) was first named *Darwinia quinqueflora* Dennst. (1818). Kanis (1987), pointed out that Dennstedt's name is validly published under

Darwinia Rudge (1815) according to the rules of ICBN.

It was also misidentified as *Tetranthera lanuginosa* Wall. by Dillwyn (1839), a species now known as *Neolitsea lucida* (D.Don) Kosterm. Hasskarl rejected this identification on the basis that Rheede's figure lacked triplinerved leaves of that species. He suggested that it could be *Litsea obovata* Nees [a Malesian species presently known as *Actinodaphne obovata* (Nees) Blume].

Suresh in Nicolson *et al.* (1988) considers the species as belonging to genus *Litsea* Lamk. probably on the grounds that the genus *Malapoenna* Adanson, which is based on Rheede's figure is rejected against *Litsea* Lamk.

As there are only two species belonging to genus *Litsea* which are known to be available in the present Malabar region, Suresh applied the rule of selection and elimination to the two species and accepts nearest one as comparable with this species, e.g. *Litsea liqustrina* (Nees) Benth.

After studying the figure and description given by Rheede, we conclude that his plant belongs to the genus *Actinodaphne* Nees, and Hasskarl was correct in placing it near to *Litsea obovata* Nees.

There is a specimen at Blatter Herbarium collected from Ekambi in North Kanara, by L. J. Sedgwick and T.R.D. Bell (No. 7271). This male specimen exactly matches with the figure of the plant given by Rheede. This specimen was earlier identified as *Litsea wightiana* but was corrected as *Actinodaphne* by B.R.Ramesh on 17th November, 1980. This specimen shows whorled leaves as shown in Rheede's figure and natural size and shape of leaves matches almost completely. Flowers also have short pedicels and match with Rheede's figure. We agree with B.R. Ramesh in the identification of this species as *Actinodaphne*.

We designate the above mentioned specimen from Sedgwick and Bell's herbarium (7271, BLAT) as the 'Neotype' of Dennstadt's name and propose new combination under the genus *Actinodaphne* Nees.

Under the present circumstances it is very evident that generic status of genus *Actinodaphne* Nees (1832) is threatened against *Malapoenna* Adanson (1771).

4. Embelia drupacea (Dennst.) comb. nov.

Pothos drupaceus Dennst., Schlusel 15, 24, 33. 1818. *Embelia viridiflora* Scheff., Myrs. Arch. Ind. 45. 1867. *E. bassal* Mez., in Engler, Pflanzenr. 4: 328, t. 954. 1902 (non DC., 1834). *E. tetrandra* Graham, Cat. Bombay Pl. 105. 1839. *Samara rheedei* Wight, Icon.t. 1591. 1850.

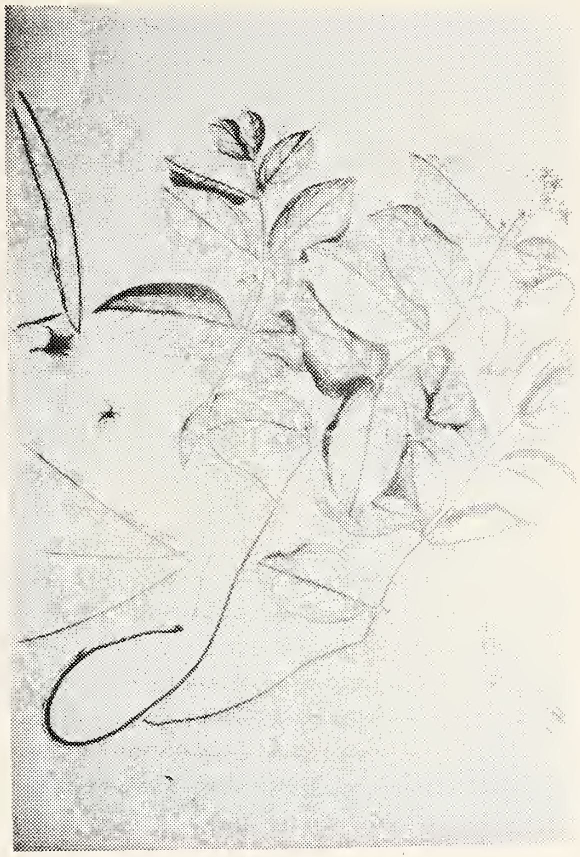
Pothos drupaceus Dennst. is solely based on the Rheede's figure of "Pu-valli" (Hort. Mal. 7: 43, t.42. 1688), Mabberly has identified it as a species of *Embelia*. Nicolson *et al.* (1988), doubtfully keep it under *Embelia ribes* Burm.f. Mabberly was correct in predicting it as a species belonging to *Embelia* Burm. f. It is presently known as *Embelia viridiflora* Scheff. (Myrs. Arch. Ind. 45. 1867). In Gamble's *Flora of Presidency of Madras,* this species goes under the name *Embelia basaal* Mez. (in Engler, Pflanzenr. 4: 328, t. 54. 1902) (non DC., 1834).

Since this species has also not yet been typified we hereby select a 'Neotype' for this species as under:

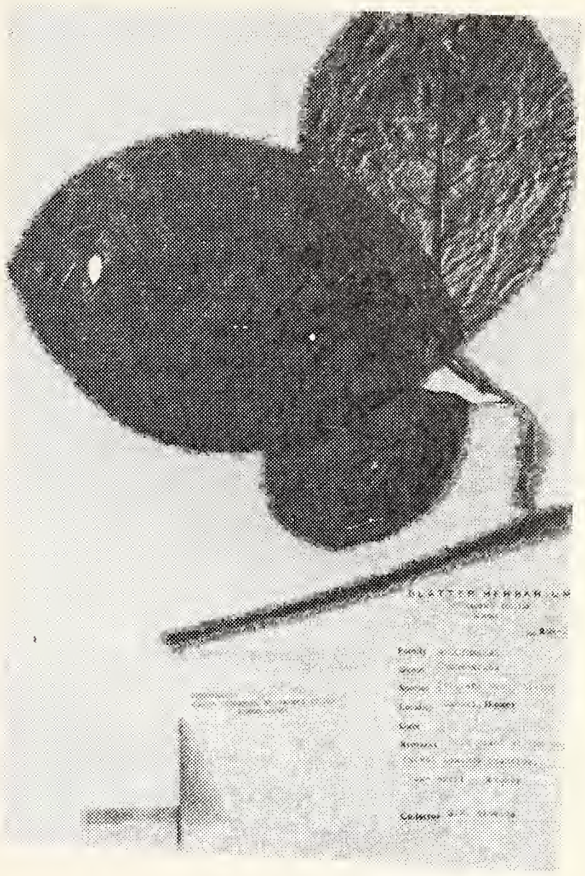
Neotype: Mahabaleshwar (H. Santapau - 11837, BLAT).

This species is a common climber in semi-evergreen forests at Mahabaleshwar.

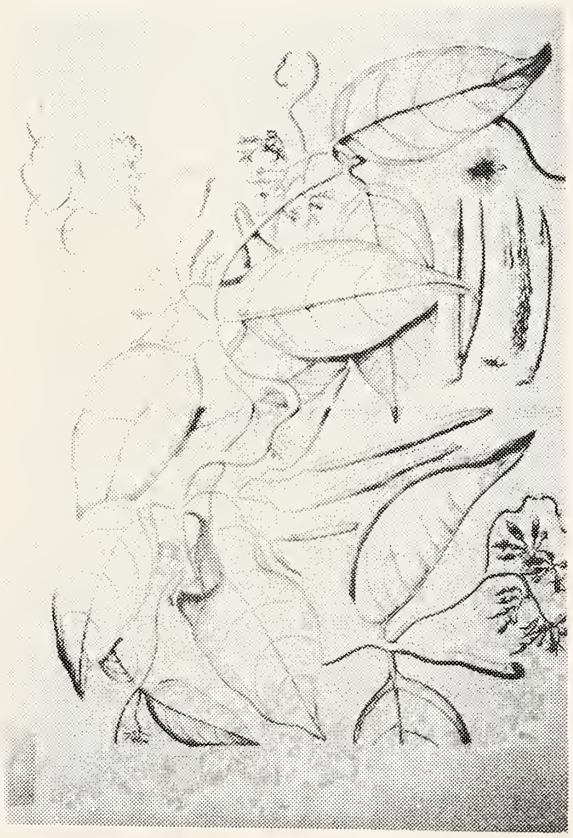
Similarly Graham's name is also without a



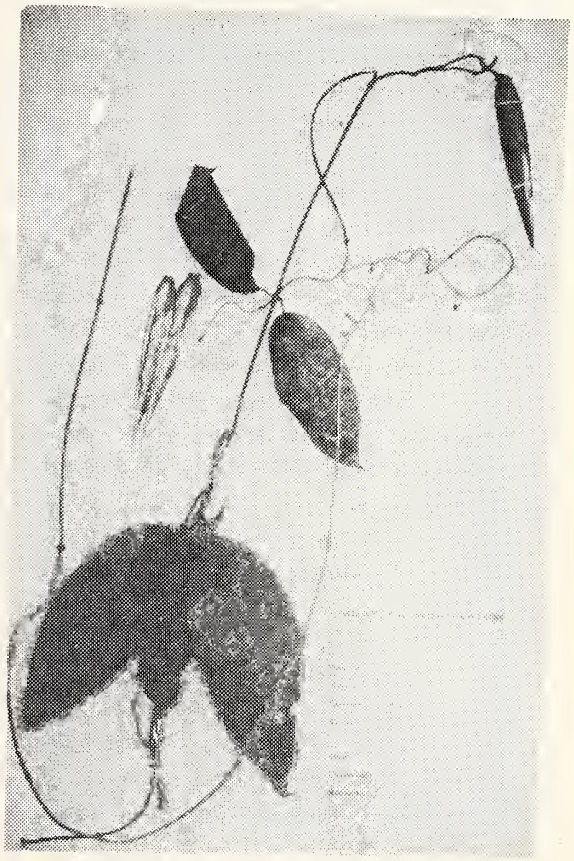
"Pal-valli"



Chonemorpha grandiflora (Roth.) Almeida & Almeida



"Kudici-kodi"



Parsonsia inodora (Lour.) Almeida & Almeida

type and his collection is also not located in any of the herbaria so far. We tentatively designate a specimen from Amboli Hills (S. M. Almeida - 1341, BLAT) as a 'Neotype' for Graham's name.

Quirivelia frutescens (Linn.) comb. nov.

Apocynum frutescens Linn., Sp. Pl. 213. 1753. *Quirivelia zeylanica* Poir, Encycl. 4: 42. 1804. *Ichnocarpus frutescens* (Linn.) R. Br., Mem. Wern. Soc. 1: 61. 1809; Aiton, Hort. Kew. ed.2, 2: 69. 1811. *Chonemorpha malabarica* (Lamk.) G. Don, Gen. Syst. 4: 76, (excl. *E. Pala*). "Pal-valli" Rheede, Hort. Mal. 9: 19, t. 12. 1689.

The present name for "Pal-valli" is *Ichnocarpus fruitescens* (Linn.) R. Br. The genus *Ichnocarpus* R. Br. (Mem. Wern. Soc. 1: 61. 1809) was established in 1809 and the card index of Index Nomina Genericum lists *I. frutescens* (L.) R. Br. as its type species. Initially, when Robert Brown described his new genus, he did not actually make a new combination but suggested that *Apocynum frutescens* Linn. belongs to his new genus. Aiton (1811), actually made a new combination under the genus and later authors cite Aiton as the author for the new combination. The genus has been conserved (from 1809) with *Ichnocarpus frutescens* (Linn.) R. Br. as its type species. However, it is not conserved against any particular earlier published generic name; in other words, no other generic name has been rejected in preference to *Ichnocarpus* R. Br.

While going through the taxonomic literature, we have ascertained that the earliest generic name validly published for this species is *Quirivelia* Lamk. (Dict. 6: 42. 1804). The sole species in genus *Quirivelia* Lamk., when initially published, was *Quirivelia zeylanica* Lamk. The specific epithet in the new genus is illegitimate name because Lamarck cited *Apocynum frutescens* Linn. in the synonymy and according to rules of ICBN, when an already existing specific name was available that should have been chosen for the specific epithet.

Since the generic name *Quirivelia* Lamk. is not rejected in preference to the conserved name *Ichnocarpus* R. Br. , it is the correct name at the generic level and must be followed. After checking with Index Kewensis we find that there are about 21 species recorded so far belonging to the genus *Ichnocarpus*. Santapau and Henry (1973) mention that altogether about 15 species occur in the world and, out of these, three are so far recorded from India. In our opinion this is quite a reasonable number for transferring under a new generic name and we propose the new combination under genus *Quirivelia* Lamk. as *Quirivelia frutescens* (Linn.) comb. nov.

As we do not know the correct identity of other species recorded from India, we are not making new combinations for them.

Chonemorpha grandiflora (Roth) comb. nov.

Echites grandiflora Roth, Nov. Pl. Sp. 136. 1821 (non Roxb. 1832). *C. fragrans* (Moon) Alston, Ann. Roy. Bot. Gard. Perad. 11: 203. 1929; Chatterjee, Kew Bull. 3: 68. 1948. *E. fragrans* Moon, Cat. Ceyl. Pl. 20. 1824. *E. macrophylla* Roxb., Fl. Ind. 2: 13. 1832 (non Kunth. 1819). *C. macrophylla* G. Don, Gen. Syst. 4: 76. 1837. *C. rheedei* Ridl., Agr. Bull. Straits Fab. Malay. States 10: 146. 1911.

The earliest name published for "Belutta-kaka-Kodi" was *Echites macrophylla* Roxb. (Hort. Bengalensis 20. 1814). However, this name is not validly published because it was not accompanied by a description of the species, nor was it cited with the reference to Hortus Malabaricus. In Flora Indica (1832), Roxburgh validated his name by giving a description and also cited Rheede's "Belutta - Kaka - Kodi". However, by that time Roxburgh's name had become illegitimate name due to two reasons. Firstly, Kunth (1819) proposed *Echites macrophylla* for some other species (now) known as distinct species - (see H.B.K. Nov. Gen. et. sp. 3: 218. 1819) and the species had been described under new names by some other authors. Presently, *Chonemorpha frangrans* (Moon) Alston being accepted as a correct name for this species. By going through the taxonomic literature, we find that *Echites grandiflora* Roth (1821) is the earliest published valid name for this species. Therefore, we propose new combination for it under the new generic name as *Chonemorpha grandiflora* (Roth) comb. nov.

We do not have any knowledge regarding any collection (Herbarium specimen) for Roth's species, but we tentatively designate herbarium specimen from Savantwadi (SMA - 2180, BIAT) as the 'Neotype' for Roth's name. In case any other type material from Roth's protologue is existent, then it should supercede this choice.

Parsonsia inodora (Lour.) comb. nov.

Cynanchum inodorum Lour. Fl. Conchinch. 166. 1790. *(A)ganosma inodora* Lour. Fl. Cochinch. 166. 1790. *Periploca alboflavescens* (Dennst.) Mabb., Taxon 26: 532, 1977. *Periploca alboflavescens* Dennst., Schlussel 12, 23, 35. 1818. *Echites laevigata* Moon, Cat. Ceyl. Pl. 20. 1824. *P. spiralis* Wall. ex G. Don, Gen. Syst. 4: 80. 1837. *Heligme rheedii* Wight, Icon. t. 4(2) : 3, t. 1303. 1848. *Aganosma laevigata* Graham, Cat. Bombay 11: 113. 1839. *P. laevigata* (Moon) Alston, Ann. Roy. Bot. Gard. Peradenia 11: 203. 1929. *Bidaria inodora* (Lour.) Decne, in DC. Prodr. 8: 624. 1844 (Sp. dub.).

"Kudici-Kodi" (Rheede, Hort. Malab. 9:13, t. 9. 1689) is currently known as *Parsonsia alboflavescens* (Dennst.) Mabberly. This name is based on *Periploca alboflavescens* Dennst. (1818), which is solely based on "Kudici-Kodi". Incidentally, there are two figures of this species in Hortus Malabaricus, the other one being "Wallia-pal-valli" (Rheede, Hort. Mal. 9: 15, t. 10. 1689). There is agreement among earlier commentators of Hortus Malabaricus that both these figures and their descriptions represent one and the same species.

During our studies on the taxonomic identities of certain Indian plants, we came across *(A) ganosma indiora* Lour. *(Cynanchum inodorum* Lour., 1790) which is said to have been described from the specimen collected by Perrottet from Pondicherry. From the description given by Decaisne (l.c.) and from the habit of its occurrence mentioned by the author as a climber of sandy sea shores it appears that it is the same species known as *Parsonsia alboflavescens* (Dennst.) Mabberly. It is described as "Plants with fistular glabrous stems having rounded-ovate or - lanceolate, quite glabrous leaves. It has a rounded or cordate leaf-base, slender petiole, short peduncles, longer pedicels, puberulous flowers, tube hairy within and stigma conical emarginate, exceeding the anthers. J.D. Hooker in Fl. Brit. Ind. kept it as a doubtful species. We propose herein a new combination for Loureiro's name as *Parsonsia inodora* (Lour.) comb. nov.

It appears that *Ganosma inodora* Lour. In the original publication is misprint for *Aganosma inodora* Lour. We presume that it is only a typographical error that has made the plant unrecognisable for so many years.

We thank Dr. (Mrs.) A.R. Daruwalla for going through the manuscript of this paper and Mr. Rajendra Shinde and Mr. Kevin D'Cruz for the photography.

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AUTUMN HOME RANGE OF MUSK DEER IN BAIZHA FOREST, TIBETAN PLATEAU[1]

RICHARD B. HARRIS[2] AND CAI GUIQUAN[3]

(With two text-figures)

Key words : musk deer, *Moschus*, Tibetan plateau, home range, habitat

Aspects of the ecology of musk deer living in a forested portion of the Tibet-Qinghai plateau were investigated during 1988-1990. A radio-collared sub-adult male occupied a home range of approximately 18 ha during November 1990, using rock outcrops for daytime resting cover and forest-meadow edges for night time feeding. Incidental observations suggested that musk deer often produce twins in this area, although fawns are difficult to see until mid-October. Estimated density of musk deer was 2-3 km^2 of occupied habitat. Musk deer home ranges occur in second-growth forests and shrub fields lacking trees, suggesting that lack of virgin forest does not necessarily preclude occupance; however, the relatively low density and wary nature of musk deer suggests that human exploitation pressures on them remain high.

Musk deer *(Moschus sifanicus)*, little studied in the past, have recently aroused greater interest among biologist as their population continues to decline. Green (1985, 1986, 1987) conducted studies in Kedarnath Sanctuary, Uttar Pradesh, India, and reviewed the status of musk deer south of the Himalayan divide. Kattel (1990) has recently concluded an intensive ecological study in Sagarmatha National Park, Nepal. However, little has appeared in English about musk deer populations in China. Musk deer occur throughout the Tibetan plateau (Feng *et al.* 1986), and the species is considered by most Chinese scientists to be *M. sifanicus* (Cai and Feng 1981), although some taxonomists have tentatively concluded that *sifanicus* should be considered conspecific with *M. chrysogaster* (Groves and Grubb 1987).

Most Chinese work has focused on either these taxonomic problems, or the difficulty of rearing musk deer in captivity. Zheng and Pi (1979) described the natural history of musk deer in northern Qinghai province, ecological studies in Sichuan province and elsewhere have recently been published (Sheng 1987, Sheng *et al.* 1990, Wang and Sheng 1988). This note provides some ecological information on musk deer living in a forested area on the Tibetan plateau, which may be useful for comparison with Green (1985, 1986, 1987) and with the forthcoming results from the intensive work by Kattel (1990) and Kattel and Alldredge (1991).

STUDY AREA

The study was conducted in Baizha Forest, a no-hunting area in Nangqian County, Yushu Tibetan Autonomous Prefecture, in south-central Qinghai Province, China, approximately 31.7° north latitude and 96.7° east longitude. Nangqian county is one of the few areas in Qinghai where forest is found, but only 106 of the county's 12,741 km^2 supports true forest, with an additional 427 km^2 classified as shrub/forest. Topography is mountainous and dissected, with both steep and rocky ravines, and gentle, grass-covered slopes. Elevations vary from approximately 3800 m to over 5000 m. Local watercourses in Baizha drain into the Ba Qu River which flows through the Tibetan Autonomous Region into Yunnan province, and later forms the Mekong River. Precipitation totals approximately 50-70 cm yearly, and most occurs between May and September.

Zhou *et al*.(1987) classify forests in Baizha as "Western Sichuan Spruce" forest type, and most

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north-facing slopes have a spruce *(Picea likiangensis)* overstorey, and an understorey made up of *Sibiraea angustata and S. laevigata* and willow *(Salix* spp.) South facing slopes consist primarily of patches of juniper *(Sabina tibetica)* distributed primarily between 3900 and 4500 m, and open grassy slopes above. Precipitous cliffs, exposed rock formations, and talus slopes are common on all aspects and slopes. Other ungulates inhabiting the area include whitelipped deer *(Cervus albirostris*), blue sheep *(Pseudobis nayaur)*, and serow *(Capricornis sumatrensis).*

METHODS

Field work was conducted during the period August 10-16, 1988; August 19-November 14, 1989; September 1- October 6, 1990; and November 1-30, 1990. Free-ranging musk deer were driven on foot into nylon tangle-nets (2m high) which were hung on vegetation or bamboo poles in suspected runways or travel corridors (Kattel and Alldredge 1991). Crews for flushing musk deer from morning resting spots varied from 1 to 14 persons, but were most often about 10. Most attempts to drive musk deer into nets were "noisy" drives, but some were "silent" drives. Because previous experience in the area indicated that musk deer generally vacated the immediate area upon disturbance, we were generally forced to set nets > 250 m from known (or suspected) musk deer resting spots, resulting in long (2-5 minute) drives, and often, misdirected animals.

Captured animals were temporarily immobilized using 10 mg Ketamine hydrochloride and 10 mg Xylazine hydrochloride (Green 1988), weighed and measured, and equipped with a 225 g radiocollar (Model 400: Telonics, Inc., Mesa, Arizona, USA). All relocations were obtained on foot, using a portable receiver and light - weight antenna. During relocations, attempts were made to make visual contact in order to maximize precision of location fixes. Because detailed maps of the study area were not available, locations were mapped using a NAV-PRO 1000 geographic positioning system (Magellan Systems Inc., Monrovia, California, USA), which fixes locations and elevations using signals received from satellites. Positions fixed using the NAV-PRO have an expected standard error of 30 m.

Home range size was estimated using the minimum convex polygon (MCP) method (Hayne 1949), and home range use was described using the harmonic mean method (Dixon and Chapman 1980). Statistical independence of successive locations (Schoener 1981) was tested using procedures of Swihart and Slade (1985). Programs MCPAAL (Stüwe 1985), and Home range (Ackerman *et al.* 1990) were used to estimate home range parameters.

Additional observations of musk deer and their sign were obtained in preparation for, or incidentally to capture efforts. Patches of open terrain and concentration of field work during early morning periods allowed for relatively good observation conditions of this usually reclusive species. Observations were aided by 7 x 42 binoculars or 10-42 power spotting scope, except unexpected encounters, which were usually of short duration.

Chinese researchers have estimated musk deer population size on the basis of pellet-group counts (Wang and Sheng 1988, Yang *et al*. 1989), but doing so requires a number of assumptions as well as a precise estimate of pellet-group density, which itself presents problems (Harris *et al.* 1992). We estimated musk deer numbers over 2 small areas of about 3 and 5 km^2 within the study area during 1991, based on discrimination of known individuals from repeated, mapped observations during and in preparation for the capture work, as well as the known home range size of the single radio-marked animal (see below).

RESULTS AND DISCUSSION

Capture and telemetry: Capture efficiency was poor; we successfully captured only a single animal in 47 drives, on November 17, 1990 (an additional animal was captured but succumbed shortly afterwards to injuries). Most drives resulted in animals flushing away from the nets, probably because of the disturbance associated with setting them up, and because we lacked sufficient personnel to direct animals toward them. The single captured animal, a male weighing 10.5 kg, was fitted with a radio-collar. One of us (RBH) estimated this animal's age as 4-6 months (born in spring 1990) on the basis of its small (5 x 2 cm) musk pod, and short (< 1 cm) canine (Green 1985).

The difficulty in capturing musk deer was similar to that experienced by Green (1985), although Kattel (1990), Kattel and Alldredge (1991) had much better success with methodology developed in Sagarmatha National Park, Nepal. The two primary reasons the present study fared more poorly than Kattel's are (1) musk deer population density are of an order of magnitude lower than in Sagarmatha, and (2) much more wary and cautious behavior on the part of musk deer in Baizha, necessitating setting up nets and organizing drives at greater distances (>250 m) from them. Our capture crew was rarely able to approach musk deer nearly as closely as possible in Sagarmatha (Kattel, pers. comm.) .The tendency of Baizha musk deer to flush at long distances and/or away from nets probably resulted from continued exposure to hunting with guns (largely absent in Sagarmatha, Kattel, op. cit.), and from living in relatively open conditions, leading to their relying more on escape and less on concealment to avoid predators.

We obtained 14 radio-fixes during November 1990, 11 of which were confirmed with a visual observation (the scheduled study period concluded in December, preventing further data collection). The animal flushed when approached by the senior investigator, but because radio - tracking was done quietly, on foot, and without accompanying persons, flushing distance was generally < 20 m, causing negligible bias in recorded locations. Location fixes were statistically independent (Schoener's t^2/r^2 = 2.43, $P < 0.05$, Swihart and Slade 1985), and although few in number, showed evidence of an asymptote in estimating the animal's seasonal MCP home range size of 17.6 ha (Fig. 1, inset). The lack of serial correlation among daily location fixes suggests that the animal traversed all, or a substantial portion of its home range daily, as suggested by Green(1985).

Use of the MCP or any 2-dimensional home range estimation procedure necessarily gives a misleading underestimate of the animal's true range use, because of the elevational variation in its steeply-sloped home range. Locations furthest from each other in longitudinal and latitudinal directions were 587 and 593 m respectively, but an elevational range of 500 m was also recorded within this small area of use (Fig.2) Slopes of location fixes averaged 47 degrees.

The estimated 17.6 ha MCP home range of the male fawn is probably biased low because of the limited sample size, restricted time-frame, and bias toward resting locations. However, it is within the 15-32 ha range estimated by Green (1985) for Himalayan musk deer, although it is larger than previous estimates from Chinese studies. Zheng and Pi (1979) estimated a 9.6 ha home range for a male musk deer in Qinghai, based on snow tracking. Sheng *et al.* (1990) estimated yearly home ranges of radio-tagged dwarf musk deer (*M. berezovskii)* of 3-7 ha in an experimental translocation to a small island in Zhejiang province, although differences in habitat may account for the much smaller range size. By contrast, Bannikov *et al.* (1980) reported musk deer home range size in the Soviet Union as 150-200 ha, an order of magnitude larger than these estimates.

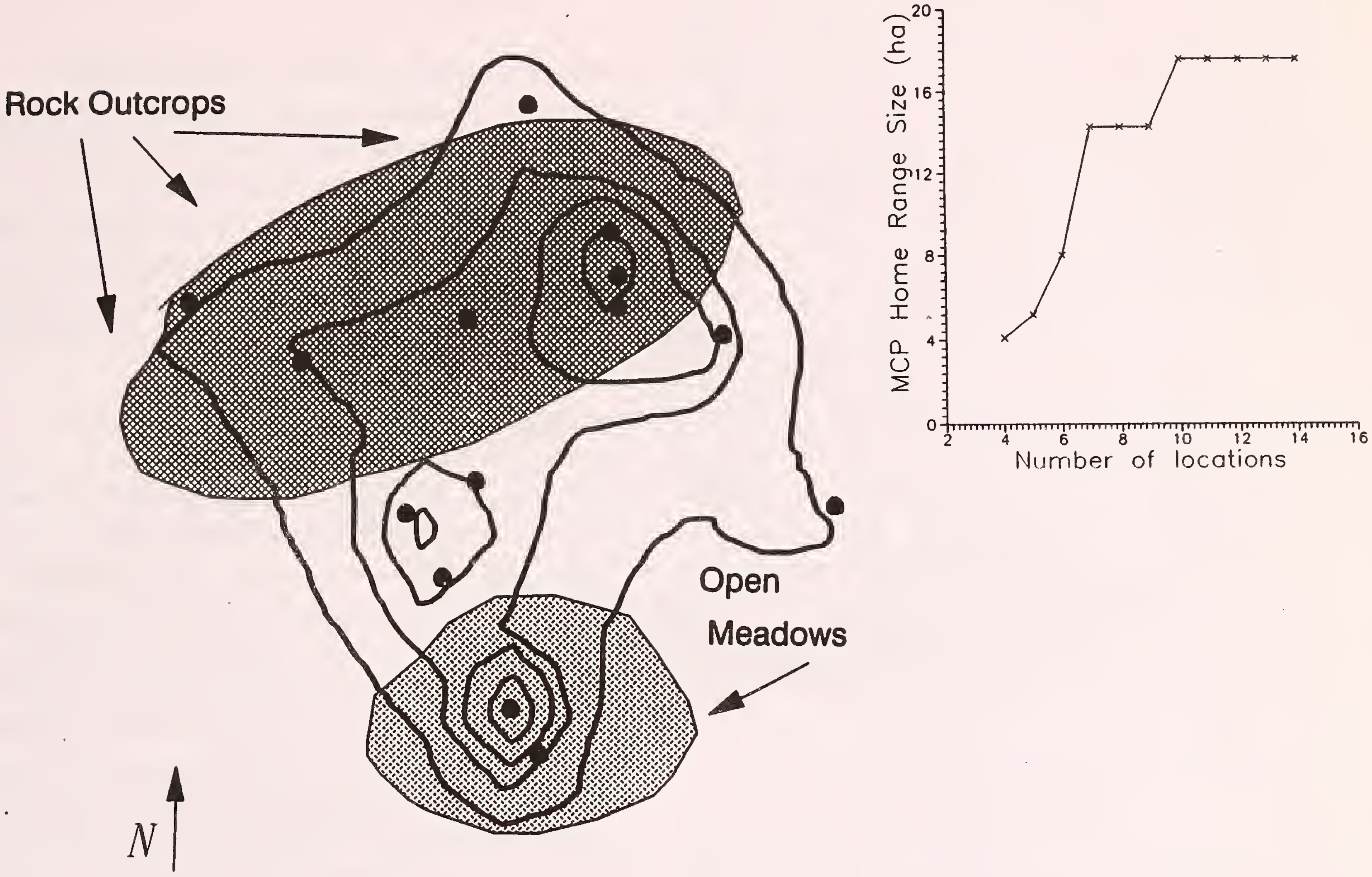

Fig. 1. Harmonic mean home range of a fawn musk deer in Baizha forest, southern Qinghai, during November 1990. Illustrated are contours of 25%, 50%, 75%, and 95% harmonic values (grid size: 10 x 10). Approximate locations of rock outcrops used for resting, and open meadows used for feeding are indicated. inset: Size of MCP estimate of home range size (ha) as a function of location sample size.

All locations recorded for this animal were on a generally north-facing slope. Early morning and late evening feeding activity occurred in both open meadows and secondary stands of spruce forest. Daytime resting sites were concentrated along a band of steep cliffs located near the northern extent of the animal's movements (Fig. 1) On 2 occasions, the animal was located resting in small rock crevices in these cliffs. Latrines and other defecation sites were also concentrated in and around these cliffs. Observations of activity suggested the animal was primarily nocturnal; resting activity was only recorded from 0745 to 1830 hrs, with feeding before and after these times. Data are therefore biased towards resting locations because it was difficult to obtain feeding locations in darkness in the steep terrain.

At least one additional musk deer was known to share this area. One of us (RBH) visually observed another musk deer, and witnessed a chase involving the marked and an unmarked musk deer, both near the southwest edge of the marked animal's range.

Incidental Observations: We observed musk deer incidentally to telemetry work 217 times, counting each musk deer seen as a separate observation. Such observations were useful for

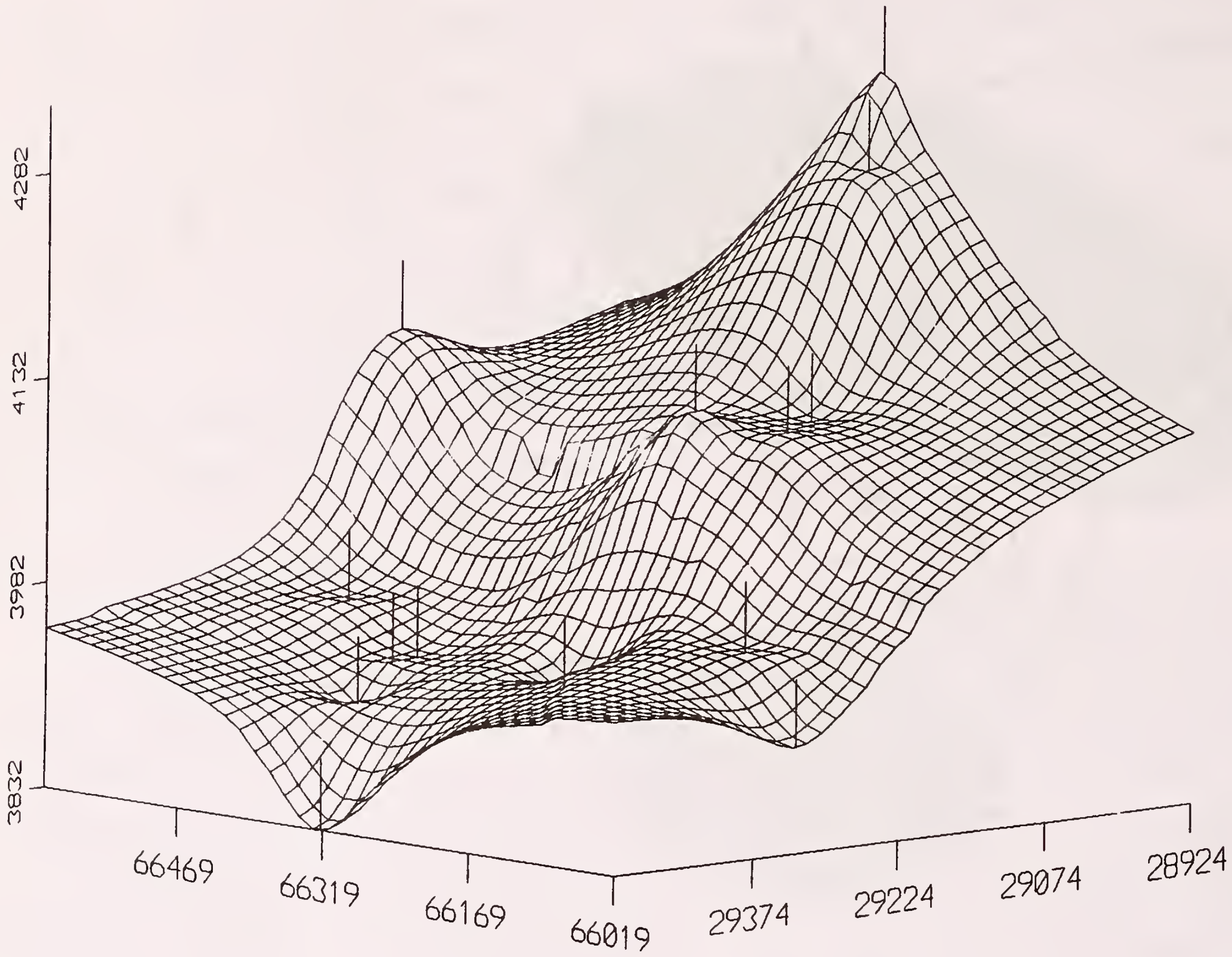

Fig.2. A surface plot of the area used by the fawn musk deer (see Fig. 1), showing individual location fixes in longitudinal, latitudinal (UTM), and vertical (m) directions. Scale on z (elevational) axis is approximately 1.4 those on x and y axes.

assessing approximate densities and habitat use, but not for quantitative analyses because they were biased by density of vegetation, time of day, observer effort, and weather conditions. The majority of observations were of solitary animals, but groups of 2 or 3 animals were observed on 19 occasions. Of these, only 1 association was known to be that of an adult male and female. Female with offspring were seen on 12 occasions, chasing behavior in which at least 1 of the 2 animals was known to be a male was seen four times, and three times the identity of 2 individuals seen in close proximity to each other could not be determined. Of 6 identified mother-offspring groups, 2 were of a single offspring, and 4 were of twins. Green (1985) reported that of 151 observations of musk deer during his study, only 1 was not of a lone animal.

Fawns in our study were not observed until mid-October (whereas adults were observed throughout the field periods), probably because, as "hiders" rather than "followers", they remained hidden among dense vegetation and were visited by their mothers for suckling bouts from birth until this time. The observation of an adult male and female in close proximity (for approximately 1 h) occurred on November 6; however, no behavior that was clearly suggestive of breeding was observed. These observations suggest that the rut begins no earlier than mid-November in southern Qinghai. It also appears that twinning occurs among musk deer in the study area, in contrast to Himalayan populations, where births are reported to be primarily single fawns (Green 1985, 1987; Kattel 1990).

Estimated musk deer density in the study area was approximately 2-3 individuals/km^2. There was no evidence of population change from 1989 to 1990, but local herders and forest guards reported that musk deer had generally declined over the previous 10 years (Harris 1991). This density is similar to that reported by Green (1985, 1987), but considerably lower than reported by Kattel (1990).

Musk deer were found in both north-facing *Picea* stands and south-facing, *Sabina* dominated aspects. Most *Picea* stands had been logged 30-40 years previously. On dry, southern exposures, patches of *Sibiraea* and open, grassy meadows were used for foraging, particularly during early morning and late evening hours. Wang and Sheng (1988) suggested that secondary forest was inferior habitat to primary forest for musk deer in Sichuan province. Comparable stands of primary forest were not available within the present study area for comparison, but secondary forest was not completely avoided by musk deer. In Qinghai's relatively dry forests with low snow depths, type of forest canopy may be less important to musk deer than the presence of forage plants and hiding cover in the shrub layer. In a separate portion of Baizha Forest, approximately 20 km distant, in which both hunting and livestock grazing was proscribed for religious reasons but which lacked trees completely, musk deer density appeared at least as high as in the main study area. This nearby area was characterized by a dense shrub layer, primarily of *Sibiraea*.

Resting sites and latrines were concentrated on or near rock outcrops and steep cliffs. All individually identified animals were associated at some time with rocky, steep security cover. Native predators on musk deer known to inhabit the area include wolves *(Canis lupus*), snow leopards *(Panthera uncia*, Harris, in press), and lynx (*Felis lynx*). However, the greatest need for escape terrain was probably to avoid domestic dogs (*Canis familiaris)* that are loosely associated with groups of nearby semi-nomadic pastoralists. Dogs were known to chase musk deer, and we also observed dogs investigating the accessible portions of rock outcrops used as security areas. The number and distribution of these rock outcrops used for predator avoidance probably limit potential musk deer density as much as do vegetative characteristics.

There was no evidence of range shifts during August-November among individually recognized musk deer. Snow-cover was generally light during the study periods, but during one period with 30-60 cm snow depth, snow tracking, like telemetry, also indicated some overlap among individual ranges, although data were inadequate to determine if individuals attempted to exclude others of the same sex.

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THE INTRODUCED BUT NATURALIZED AVIFAUNA OF THE UNITED ARAB EMIRATES[1]

Mohammad Ali Reza Khan[2]

(With a text - figure)

Key words : UAE, introductions, residents, migrants, distribution, breeding, food

During the last four decades the number of bird species introduced in the United Arab Emirates (UAE) has gone up to 60, out of a total of 360 species so far listed here. Over a dozen of these have established themselves as potential breeding residents and are colonising new areas.

Introduction

About a decade ago there existed literally no published information on the birds of the UAE. A privately circulated list (Warr 1988) is considered to be the first full report on the birds sighted here during the last four decades or so. A fully comprehensive report on the UAE birds and their expected status in UAE, on a month-wise basis, has been published in November, 1990 (Richardson 1990). He mentions that some 360 species of birds are likely to be present in UAE. Out of these only 70 or so species are breeding here. That too all of them are not permanent residents of UAE. Some are only breeding migrants and several are escapes from private collection which have become permanent breeding residents. Richardson noted over 50 such species.

This paper deals with the present status of the species which have been introduced in UAE either intentionally or are escapes from captivity and have established themselves as breeding residents. This is based on my personal observations as well as the information available in the literature. Additional information was obtained by contacting serious birdwatchers (Colin Richardson and J.N. Bish Brown, pers. comm.). My personal observations date back to December, 1983 when I first arrived in the UAE and started working in Al Ain Zoo, where I have noted over 100 species of birds up to May 1989, when I shifted to Dubai. I was amazed to see Common Myna and Rose-ringed Parakeet building nest in the Al Ain Zoo premise. This inspired me to note the introduced species.

Study Area

Location: The UAE became a federated nation of seven self-governed Emirates, namely Abu Dhabi, Dubai, Sharjah, Ajman, Ummal Qawain, Ras al Khaimah and Fujeirah (Fig.1) in 1971. UAE has an area of about 83,000 km^2 at the southern tip of the Arabian Peninsula, lying between 20°50' to 26°N and 51° to 56°E (Western 1989). It is a horse-shoe shaped country whose western end meets Qatar and Saudi Arabia, Eastern side is contiguous with Oman and portion of it meeting the Arabian Sea through the Gulf of Oman. The entire north is bounded by the Arabian Gulf. Both the south and part of the west merges with the arid 'Empty Quarter' of the Arabian Peninsula.

Climate: The Climate is typical of the desert environment. The difference between day and night temperature is usually above 10° C and the average annual rainfall is below 250 mm. Although some areas, especially the 'eastern hilly terrain and coastal belt received more rain than the interior arid zones'. Average annual humidity is 60% in the coastal belt and less than that in the interior. The lowest temperature usually ranges from 9° to 12°C during November to February. The highest temperature

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[1] Accepted January 1992.

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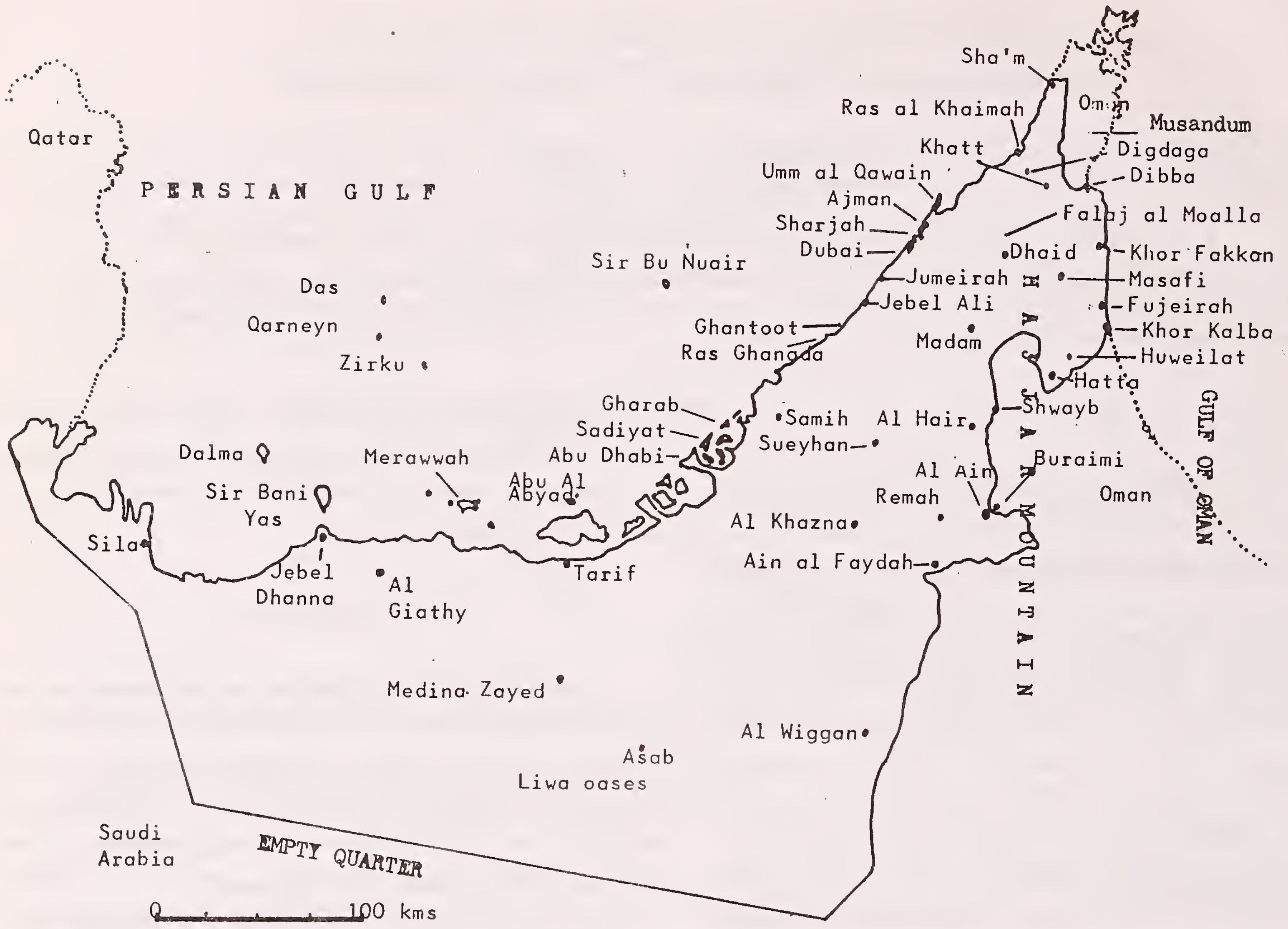
Qatar
PERSIAN GULF
Sha'm
Ras al Khaimah
Oman
Musandum
Khatt
Digdaga
Umm al Qawain
Dibba
Ajman
Sharjah
Falaj al Moalla
Dubai
Dhaid
Khor Fakkan
Sir Bu Nuair
Jumeirah
Masafi
Jebel Ali
Fujeirah
Das
Qarneyn
Ghantoot
Madam
Khor Kalba
Ras Ghanada
Huweilat
Zirku
Hatta
Gharab
Sadiyat
Samih
Al Hair
Shwayb
Abu Dhabi
Sueyhan
Dalma
Merawwah
Buraimi
Al Ain
Abu Al Abyad
Sir Bani Yas
Remah
Oman
Al Khazna
Sila
Tarif
Ain al Faydah
Jebel Dhanna
Al Giathy
HAJAR MOUNTAIN
GULF OF OMAN
Medina Zayed
Al Wiggan
Asab
Liwa oases
Saudi Arabia
EMPTY QUARTER
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Fig. 1. United Arab Emirates showing major towns, islands, oases,and mountains (Modified from Wstern 1989).

ranges from 45 to 49 °C during June to August. The lowest temperature occasionally reaches as low as 5°C and the highest 52°C. Both rainfall and temperature are very erratic in UAE and varies a great deal from place to place and year to year (El-Ghonemy 1985, Western 1989).

Topography: A detailed topographical features of the UAE have been provided by El Ghonemy (1985) and Western (1989). So far as the scope of the present paper is concerned the UAE may be divided into six distinct habitat types : offshore islands, coastal lowlands, western dune plain, the central desert, the alluvial plain and the mountain belt.

The offshore islands are usually close to the mainland of Abu Dhabi. But some are far off, even over 100 km from the nearest coast of the Arabian Peninsula.

The coastal lowlands of both west and east coast comprise most recently formed saline flats or sabkha. The majority of human habitations and city centres have developed along the coastal belt of the country.

Most of the UAE comes under the category of western dune plain. The south-west region of the country comprise extensive gravel plain with banks of aeolian sand piled up by the prevailing winds, e.g.

Liwa and Al Waggan oases.

The central desert extends from Abu Dhabi to Al Ain. It is formed of semi-mobile dunes and has a relatively high water table. This area is actually an 'island sabkha'.

The alluvial fan that extends and spreads out westward from the Hajjar mountain range forms an extensive plain with shallow and ever-decreasing slope until levelling out when they meet the central desert. These areas comprised pebbles and rock detritus overlying gravelly alluvium close to the mountains, and sand and gravel further west. The plains around Khatt, Digdaga, Dhaid, Madam, Hatta, Al Hair and Al Ain are quite fertile. Thus supporting oases, townships and farming villages.

The mountain belt include theHajjar mountain ranges starting at a point near Al Ain in the south-east and extending northward up to Sham, bordering the Musandum peninsula of Oman in the north-east. In the extreme east the range merges with the Gulf of Oman. The range is very harsh with remote and isolated peaks, often reaching 1000 m above msl. near Ain Al Faydah. The dry, scrub-scattered slopes look desolate. There are a few oases within the mountain range, namely Hatta, Dibba, Masafi and Huweilat. A number of dried up river beds, locally called wadis, traverse the entire range. These may bring flash floods in a matter of hours if there is rain in the upper regions of the mountain.

Man-made environment: All the seven emirates have developed their city centres and the suburbs in such a way that there is no dearth of greenery here. These are mainly established as municipal parks and public gardens. Some hotels and tourist centres have acres of grassy lawns dotted with ornamental as well as local plants. There are many farming communities with vast arable lands around Abu Dhabi, Al Ain, Dubai, Sharjah, Ras Al Khaimah and Fujeirah.Couple of golf courses attract a lot of birds too.

Vegetation: The commonest natural trees and woody shrubby species are dominated by *Acacia tortilis, Prosopis cinerea, Phoenix dactylifera, Zizyphus spina-christi, Tamarix arabica, Ficus carica, F. salicifolia, Avicennia marina, Calotropis procera, Nerium mascatense, Moringa peregrina, Salvadora persica, Capparis cartilaginea,* etc. The most widely seen introduced species and growing very wild is the *Prosopis chilensis.* In the cities, suburbs and man-made parks and gardens we have hedges of *Clerodendron inerme, Bougainvillea spectabilis, Nerium oleander* and *Vitex negunda.* The trees belong to *Acacia arabica, A. nilotica, Albizia lebbek, A. chinesis, Terminalia catappa, Delonix regia, Melia azedarach, Thespesia populnea, Ficus bengalensis, F. religiosa, F. elastica, Casuarina equisetifolia, Inga dulce, Cocos nucifera, Tamarindus indicus, Moringa oelifera, Eucalyptus camaldulensis, Zizyphus jujuba, Parkinsonia aculeata, Tecoma stans, Cordia myxa, Pongamia pinnata,* etc. Other ornamental garden plants include *Hibiscus rosa-sinensis, Dodonea viscosa, Nerium* spp., *Plumeria rubra, P. alba, Gardenia, Lantana camara, Caesalpinia pulcherrima, Bauhinia* spp., *Pandanus odoratissimus, Cassia* spp., *Allamanda* sp., Bottle Brush, etc.

BACKGROUND

In the early sixties (1962) when UAE first struck oil prosperity boomed here. The rulers of different emirates, locally called 'sheikhs' started getting a lot of animals as gift from the neighbouring countries of the Indian subcontinent, Persia, Middle east, Europe and Africa. Moreover, whenever the local dignitaries went on a visit to a country they sought or collected a variety of animals of their own choice and brought them to UAE. Sometimes military transport planes were used to bring full load of animals from Africa (Otto. J. Bulart, pers. comm.). This trend continued even up to the early eighties

(Heinz Eller, pers. comm.).In one instance, during August 1984, over 5,000 Pintailed Sandgrouse arrived in Al Ain Zoo as a gift from Syria (!) to a local dignitary. During my five and half years stay at Al Ain Zoo, on many occasions we were told by the authorities to receive and then release the Black Francolin, Grey Partridge, Chukar Partridge, Common Partridge, Mallard, African Yellow-legged Spur-fowl, Stone Curlew and Dikkop in the private gardens, man-made forests and Islands of Abu Dhabi emirate. These were released in hundreds. So one can expect many birds of African, Asian and European origin to occur in UAE as these either escaped from captivity or were released systematically by the social elites to 'increase' the local avifauna without knowing the consequences.

Observation and Discussion

So far, over 50 species of birds have been introduced intentionally or unknowingly whereas a few have possibly crossed the sea-route abroad ocean-going vessels and oil tankers (J.N. Bish Brown, pers. comm., Gallagher & Woodcock 1980, Pilcher 1986). Among them the House Crow, Grey Francolin (Partridge), Common Myna, Rose-ringed Parakeet and Ring Dove got established in such a way that it is hard to believe that they have been introduced. They occur in large numbers. A party of 100 myna, 100 parakeet and a couple of dozens of crows heading for a roosting site is a common sight in parts of UAE . On one evening, in December , 1990 I counted over 1, 000 Ringed Dove which came to Saffa park (at Dubai) Bird Pond to roost on some 100 *Prosopis chilensis* trees. Where there were already over 2,000 Palm Doves, 300 Common Myna, 50 House Crow, many House Sparrows, Mistle Thrush, Reed Warbler and Chiff-chaff waiting to spend the night.

An approach is made here to furnish a species-wise account and discussion on the introduced species which are commonly seen in the UAE.

Collared Ring Dove *Streptopelia decaocto decaocto* (Frivaldszky)

The Collared Dove occurs from Scandinavia to E. China (Ali and Ripley 1983), Iraq, Persia to Palestine and E. Arabia (Gallagher and Woodcock 1980.) Richardson (1990) states that it was, first seen in Arabia in 1963, though scarce in UAE prior to 1977. Gallagher and Woodcock (1980) considered it as a passage migrant and winter visitor; .. also a breeding resident on N. Batinah and Salalah (in Oman), locally common. By 1991 the Collared Dove had established itself as the commonest resident bird of UAE. It occurs in great numbers in the Saffa and Mushrif parks of Dubai city, Ain Al Faydah Tourist Centre and Zoo at Al Ain city, Digdaga, Dhaid, Khatt, Madam, Al Hair and Hatta area. It often roosts in great numbers. Before going for the roost, this dove often congregates on the electric wire by the side of the highways in the farming villages. It is not uncommon to see this species outnumbering the locally available resident Senegal/ Palm Dove *Streptopelia senegalensis.*

The preferred nesting sites of the Ring Dove include *Prosopis* trees, *Acacia tortilis* and *Zizyphus* trees. The breeding season extends from February to August and May-June seems to be the peak period of nesting activities. A pair nested behind my villa within the Dubai Zoo premise during April-May, 1991. It was on a *P.cinerea* tree, about 6 m above the ground level. Ring Dove prefers seeds of cultivated crops, in addition to seeds and tiny fruits of desert plants and those left over by humans.

Common Myna *Acridotheres tristis tristis* (Linnaeus)

In the city limits, suburbs and man-made areas the Common Myna is the commonest bird of UAE. It is almost impossible to believe that it did not occur in the UAE even during the seventies. "Said to occur as a naturalised escape at Al Ain, UAE" Gallagher and Woodcock (1980). Ali and Ripley (1983) did not mention it to be present in Arabia. As per Richardson (1990) it is a widely introduced, locally abundant, resident, breeding freely, and spreading. Often roosts freely in large flocks.

The nesting season begins at the end of winter and lasts up to mid-summer with most nestlings out in the open during April-May. Most preferred nest-sites are the holes in the buildings, broken lamp-posts and lamp - shades. Once in Al Ain city I found a nest with nestlings in the space between the cover of an airconditioner and the wall of the building holding the a/c at a fourth floor appartment.

The Common Myna almost entirely feeds on garden refuse, insects, larvae and worms and occasionally grains and seeds.

So far, Brahminy Myna *Sturnus pagodarum,* Pied Myna *sturnus contra* and Bank Myna *Acridotheres ginginianus* have been reported to be breeding in the emirates. I found an active nest of a Brahminy Myna at Sharjah in late-April, 1990. It was on a broken lamp-post in a residential area. The parents were carrying food for the chicks. These species are not breeding regularly and there seems to be no well-established population. Bank Myna breeds regularly on the bank of old and disused wells in Digdaga and Khatt area.

HOUSE CROW *Corvus splendens* VIEILLOT

Quite common in the Arabian Gulf coastal towns from Musandum in the north-east to Abu Dhabi in the west and Al Ain in the south. It has extended its range up to Kuwait (Pilcher 1986). Also very common in the coastal areas of Gulf of Oman where it is counted by the thousands (Stanford 1973). First appeared in the east coast of UAE possibly on board oceanic vessels in the early seventies either from southern Iran or the Indian sub-continent. Usually not found in the oases far away from the coastal township and fishing villages.

The areas where currently the House Crow is resident in the UAE it seems to occupy the top position in the food chain. It is to some extent ecologically equivalent to some of the birds of prey. The latter group includes a band of kestrels and some owls which occur here seasonally. The crow feeds on the nestlings of House Sparrow, Blue Rock Pigeon (Dove), other doves, mynas and domestic birds, in addition to dead fish and carrion. Thus it is not only scavenging but also keeping a sort of check on the unlimited growth of the introduced avifauna that share the habitat of the House Crow.

Some amateur birdwatchers have become alarmed by the recent expansion of the range of the species and its increase in number. They have even suggested to the Dubai Municipal authorities that they (DM) should wipe out the crow population (Colin Richardson and Alan Dickson, pers. comm.). I don't think the crow population has gone up to such an extent that we need a systematic destruction of it from the UAE. As there is no carrion-feeder in the man-made areas the presence of House Crow might be considered as a blessings in disguise.

The House Crow roosts communally or in pairs. March to May appeared to be the nesting season. In the absence of nest/brood parasites like the koels and cuckoos, the House Crow is capable of raising a whole clutch in its entirety. Preferred nesting trees are *Prosopis, Acacia, Eucalyptus & Tamarix.*

Whether the House Crow is an unintentional introduction by man or it has extended its natural range by crossing the Arabian Gulf, that is from coastal southern Iran (Pilcher 1986) has not yet been established with certainty.

Rose-ringed Parakeet *Psittacula krameri borealis* (Neumann)

The Rose-ringed Parakeet is one of the

commonest commensals of man especially so in the urban areas and farming villages. Sometimes they occur in large flocks of over one hundred birds and damage the cereal crops and fruit orchards. There is no definite date of introduction of this species in UAE but has been referred in all the recent literature of UAE and Oman. Back in 1974 I have seen arabs buying parakeets from Crawford Market of Bombay, India. Many pet shops still sell parakeets in different emirates of UAE. Uncounted numbers must have escaped from captivity.

The breeding season extends from December to May with a peak in March-April. Preferred sites are holes and crevices in buildings, trees and broken lamp-posts. Once in Al Ain Zoo a pair built a nest inside the horizontal exhaust, steel pipe (5 cm diameter) of a diesel generator, which remained unused for most part of the year as literally there was no failure in the supply of electricity.

The natural diet of parakeet in UAE includes seeds of *Acacia tortilis, Prosopis cinerea,* nuts of *Terminalia catappa, Zizyphus* and *Melia* fruits. Flowers and seeds of sunflower, *Capparis, Salvadora* etc.are eaten almost regularly. They often raid crop fields, mango, date palm, guava and sapota gardens. As they cause heavy damage to the crops and fruits farm and private garden owners often shoot them.

Grey Francolin (Partridge) *Francolinus pondicerianus mecranensis* Zarudny and Harms

Peters (1934) is possibly the first to mention it to be present in eastern Arabia (Muscat) when Ali and Ripley (1983) showed its extra-limital distribution as southern Afghanistan, Southern Iran, Eastern Arabia (as referred by Peters). Howard and Moore (1980) do not include Arabia within the range of the species possibly because it has been introduced in the area. It is a common breeding resident in Musandum, south through north Oman and Dhofar (Gallagher and Woodcock 1980). Richardson (1990) mentions it to be, common, even abundant resident in some areas. Warr (1988) says, some, if not all were introduced.

The Grey Francolin is now a common resident of almost all the urban, suburban and newly developed countryside townships or clustered houses. The date garden, public garden, parks, roadside shrubberies are the usual abode for this francolin. It is more often heard than seen. The road - side plantation of Dubai City, especially the ones passing through the less populated areas like Satwa, Jumeirah and Bur Dubai support a good population.

The Grey Francolin has been introduced in different emirates of UAE in hundreds during the seventies, eighties and even beginning of this decade. So it is almost impossible to say whether the range of the introduced population has extended from the Musandum peninsula and Hajjar Mountain ranges to westward into the UAE or the ones systematically released in the emirates have colonized the country. But now it is a common and regularly breeding resident bird of UAE.

Very raucous during the breeding season, February to June, although most fledglings are seen during May. Build nest on the ground, usually under a well-concealed branch of *Prosopis* or *Acacia* touching the ground. The nest is not more than a lined scrape. Usually 4 to 6 chicks are seen following the parents in quest of food.

Feeds mostly on the grains, seeds, dates, shoots of the plants of the area it colonises. Also consumes insects, worms and larvae. Sometimes ventures out to busy roads, islands and well-watered round - abouts to pick up windblown seeds and refuse tit-bits.

Colonising all newly developed areas at a much faster rate than all the other introduced species. The other reasons being that it is growing almost in a predator-free situation. Only natural predator is the Arabian Fox.

Chukar *Alectoris chukar,* Black Francolin *Francolinus francolinus* and Quail *Coturnix coturnix* have been sighted in UAE. As far as my experience goes the first two species have been introduced by the Government of Abu Dhabi and Al Ain in the recent past. Richardson (1990) says that a small population of Chukar introduced some years ago exists in Musandum (Oman) and strays have been reported in the Dibba area. A definite and continuous breeding of these species and Quail have not yet been reported. The latter is bred commercially in several farms, and in Al Ain and Dubai Zoos.

White-cheeked Bulbul *Pycnonotus leucogenys leucotis* (Gould)

Of the five sub-species of White-cheeked Bulbul, three occur around the Arabian Gulf countries: *P.l. mesopotamiae* in Iraq, *P.l. dactylus* in E. Saudi Arabia and *P.l. leucotis* in southern Iran to north-west India (Howard and Moore 1980). Ali and Ripley (1983) also include Iraq and Saudi Arabia in the distributional range of the species. Gallagher and Woodcock (1980) mention the species to be breeding in S. Iraq, S. Iran, Bahrain and the mainland nearby, and NW India. About its status in Oman they say, it has been reported very rarely, presumably as an escaped captive bird. Warr (1988) quoting other scientists suggest that it might be an introduced one. Richardson (1990) definitely mentions it as an uncommon resident breeder of Gulf coastal towns and cultivations, currently spreading inland. The species is well-established in the Mushrif Park of Dubai, parks and gardens of other emirates.

The breeding season extends from January to August with a peak in April-May. I found a nest in mid-February at Mushrif park which was under incubation by the parent. At the beginning of May, the same year two pairs were found attending freshly fledged chicks, still incapable of proper flight.

The White-cheeked Bulbuls are mainly dependent on juicy, soft berries and fruits. They consume figs, fruits of neem, *Lantana, Salvadora, Capparis, Zizyphus* and nectar from the flowers of *Vitex, Tecoma* and bottle-brush, and insects. After rain makes aerial sorties to catch flying ants (termites).

Red-vented Bulbul *Pycnonotus cafer* (Linnaeus)

There seems to be an uncertainty with regard to the sub-specific status of the Red-vented Bulbul in UAE mainly because the population here is represented by purely introduced specimens, which have escaped from private possessions. But *P.c. humayuni* Deignan is likely to be the one. It is widespread in India and Pakistan. The Arabs might have brought them from the subcontinent as they pay frequent visits to these two countries.

The Red-vented Bulbul frequently intergrades with the local species, Yellow-vented Bulbul *Pycnonotus xanthopygos* and introduced White-cheeked Bulbul producing a variety of intermediates ranging from black cheek to Yellow-vented variety as referred by Richardson (1990) and others.

The food and breeding season and habits, preference for the habitats for the Red-vented Bulbul in UAE are apparently similar to the White-cheeked Bulbul. To me the red-vented appears to be more shy than the white-cheeked. Also lesser in number than the latter species.

Red-whiskered Bulbul *Pycnonotus jocosus* is represented by a few, apparently resident, pairs in Dubai. One pair frequents Jumeirah area. Said to be escapes from captivity.

Mallard *Anas platyrhynchos platyrhynchos* Linnaeus

The Mallard is one of the most recent introductions in the environs of UAE. Between 1984 and 1986 more than 3,000 mallards in full plumage were released in two artificial lakes at Ain Al Faydah, a tourist resort built around an oasis of Al Ain. By the beginning of 1991 I found none of them excepting a few pairs which I presumed to be natural winter migrants. I guess many thousands have been released on different islands of Abu Dhabi and other emirates by the local dignitaries.

Warr (1988) reported, a couple of hundred introduced in 1984 into Dubai; present all months and breeding freely with young in May. Gallagher and Woodcock (1980) mentioned it to be a winter visitor to Oman. Ali and Ripley (1983) did not mention it to be present in the Arabian Peninsula where Richardson (1990) says that its status is obscured by the existence of introduced flocks which breed in early spring.

Back in 1985 Matiur Rahman, the Photographer of a local newspaper, "Khaleej Times", published a black-and-white photograph of a mallard incubating a clutch of over a dozen eggs in the Khor Dubai area of Dubai township. Even now there is a small breeding population in Khor Dubai area. During August 1990 I found seven juvenile mallards there. Up to now a few pairs have bred in Khor Dubai, Al Ain Zoo and Sir Bani Yas Island, off the Abu Dhabi coast.

There are a few records of the breeding of Egyptian Goose *Alopochen aegyptiacus* from Al Ain and Abu Dhabi. These are possibly the birds which escaped from Al Ain Zoo and private collections. There is no established population.

Indian Silverbill (Whitethroated Munia) *Lonchura malabarica* (Linnaeus)

"Small parties in mountains and gravel plain. An apparently isolated resident population in Dubai area, first recorded in 1975 and possibly introduced or escapes", says Warr (1988). Gallagher and Woodcock (1980) noted it as a breeding bird of E Arabia, SE Iran to India, Sri Lanka. Fairly common and widespread in N. Oman (not Masirah) with regular and seasonal movements, they were noted outside the Indian subcontinent and extralimitally ranges west to southern Arabia. Some subspecies in Africa south to Tanzania (Ali and Ripley 1983).

In UAE Indian Silverbill seems to be one of the commonest birds associated with human settlements. From a few dozen birds the number has crossed well over 100 between 1984 and 1991 in a little two square kilometre of developed area of Al Ain Zoo. Sometimes over 50 birds seen within the 2 hectare Dubai Zoo compound. Here they enter the finch-cum-budgerigar aviary, through its one square inch weldmesh to get their daily ration and sometimes to escape the local showers. Although Spotted and Black-headed Munias are also found in the zoo they can not enter into the nest through the weldmesh possibly because they are little bulkier than the silverbill.

The Indian Silverbill have been found in the remotest human settlements in areas like hugged mountains, Liwa and Al Wiggan.

Most birds breed between January and March. Preferred sites are hedges of *Clerodendron, Vitex, Euphorbia tirucalli, Tamarix, Acacia, Prosopis, Bougainvillea* and *Zizyphus* trees.

One of the delicacies that the silverbills definitely have in their menu is the seed of local grasses like *Pennisetum divisum, Panicum turgidum* and *Scirpus*. They visit these low bushes in flocks and are often found in the company of the House

Sparrow, House Bunting and other buntings.

Red Avadavat *Amandava amandava*, Chestnut (Black-headed) Munia *Lonchura malacca*, and Scaly-breasted (Spotted) Munia *Lonchura striata* have been seen in several parts of the emirates. As mentioned earlier the last two species, sometimes with dye applied by their captor, are even seen in Dubai Zoo. But up to now their continuous breeding to get the status of a resident breeder has not yet been established. Although Richardson (1990) has reported stray nesting.

CONCLUSION

It appears from the species-wise description and discussion that most introductions have taken place around centres of human activities, that is the coastal cities and oases. From these centres the birds are extending their range in various direction. Although the main dispersal seemed to be, roughly, from East to West mainly because the majority of human settlements have in the past and present are taking place along this direction following the Arabian Gulf coast. The availability of man-made greenery, including parks and gardens, farming villages and artificial oases are also contributing to the present trend of wilful and unintentional introductions and establishment of the species.

Before some mistakes are made in introducing the wrong species, which may ultimately wipe out some local fauna and flora, government should come forward with a clear policy on introductions. There needs to be an establishment of a centre to monitor the already introduced species and the ones to be introduced in the future. A practical scientific approach cannot be provided by the amateur bird-watchers or the natural history groups alone without the firm and continuous backing of the government.

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POST HATCHING DISPERSAL AND GROWTH OF THE SALTWATER CROCODILE, *CROCODYLUS POROSUS* SCHNEIDER, IN ORISSA, INDIA[1]

S.K.KAR[2]

Key words : grow and release, wild hatchlings, captive husbandry

This paper describes the post hatching dispersal and growth of the Saltwater Crocodile, *Crocodylus porosus* Schneider in the river systems of Bhitarkanika Wildlife Sanctuary, Orrisa for a period of three years. A comparison has been made on the growth of the captive reared hatchings at the Crocodile Research Centre, Dangmal with the same age-group of wild caught hatchlings. Factors responsible for survival of the wild hatchlings have been highlighted.

INTRODUCTION

The saltwater crocodile, in India was critically reduced in number as a result of over hunting for skins as well as over exploitation of mangrove habitat (Bustard 1974, Behura and Kar 1984, Daniel and Hussain 1975, Kar 1978, 1981, 1985; Kar and Bustard 1989). With the initiation of the Government of India / FAO / UNDP project "Crocodile Breeding and Management" early in 1975, a scheme for conservation of saltwater crocodiles was implemented by the Forest Department, Government of Orissa alongwith Gharials, *Gavialis gangeticus* and Mugger crocodiles, *Crocodylus palustris*. A saltwater crocodile Research and Conservation Centre was established at Dangmal in the heart of the Sanctuary with the purpose of quickly multiplying the population using the 'grow and release' technique to save this endangered reptile.

During the study period, maximum emphasis was given to collection of wild laid eggs from the Bhitarkanika Wildlife Sanctuary for safe hatchery incubation by simulating natural conditions, rearing the young with sound husbandry, release of the crocodiles (above 1.0 m length) in the river systems of the sanctuary, monitoring the released crocodiles and collection of relevant data on wild and captive population of C. *porosus*. This paper describes the post hatching dispersal of the saltwater crocodiles, in the river systems of Bhitarkanika Wildlife Sanctuary, Orissa for the years 1975, 1977 & 1978. Weight and measurement and survival of the wild caught hatchlings and location were recorded.

MATERIALS AND METHODS

In the course of a detailed ecological study on the saltwater crocodiles in the Bhitarkanika Wildlife Sanctuary of Orissa (commencing in 1975 and still continuing) hatchling saltwater crocodiles were collected when located. Since all natural nests eggs were collected as soon after laying as possible for captive incubation and subsequent rearing of the young prior to the release back into the wild as part of the conservation management programme (FAO 1975), these hatchlings resulted from nests which had been missed.

Following collection of wild hatchlings from an area every effort was made to locate the nests from which they had come. Knowledge of the nesting site permitted calculation of the distance moved by the hatchling and their age was calculated. In Bhitarkanika most nests were laid within a few days of each other at the end of May (Kar 1981, 1984, 1985; Kar & Bustard 1989) and hatch around the end of the second week of August. In this study, for purpose of comparison, a hatching date of 15 August

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was assumed for all hatchlings.

Since hatchlings from wild laid eggs have been reared each year in the Saltwater Crocodile Research and Conservation Centre located at Dangmal within the Sanctuary, it is possible to compare growth rates of captive and wild hatchlings.

Data on this topic were collected in the three years 1975, 1977 and 1978. No wild hatchlings were seen in 1976 probably as a result of a very successful egg collection in that year.

RESULTS

In the present study, no hatchlings were observed with large crocodiles.

Dispersal: The distance moved by hatchlings from the nest in relation to their age in days is given separately for the three years in Tables 1 - 3. The locations of the nests from which the hatchlings were collected and the collection points of the hatchlings was been indicated. Data for the three years are as follows:

TABLE 1
CAPTURE DATA ON
WILD HATCHLINGS DURING 1975

No.	Date of collection	Age (days)	Length (cm)	Weight (g)	Distance moved from the nest (km)	Attributable to nest numbers
1.	23.09.75	39	30.6	67.0	1.0	1
2.	11.10.75	57	34.5	79.8	2.05	1
3.	28.10.75	74	34.2	75.2	2.8	2
4.	28.10.75	74	35.5	81.0	2.83	2

TABLE 2
CAPTURE DATA ON WILD HATCHLINGS DURING 1977

No.	Date of collection	Age (days)	Length (cm)	Weight (g)	Distance moved from the nest (km)	Attributable to nest numbers
1.	24.9.77	40	30.6	66.2	*	1
2.	25.9.77	41	32.0	75.5	*	1
3.	29.9.77	45	32.5	77.0	3.0	2
4.	29.9.77	45	31.7	72.8	3.2	2
5.	30.9.77	46	32.6	75.2	2.0	2
6.	30.9.77	46	32.6	81.0	1.5	2
7	30.9.77	46	33.0	81.7	1.35	2
8.	1.10.77	47	35.0	86.0	0.7	2
9.	1.10.77	47	34.8	77.7	0.8	2
10.	1.10.77	47	33.0	82.0	1.0	2
11.	2.10.77	48	33.0	81.2	1.3	2
12.	2.10.77	48	32.9	80.2	0.9	2
13.	2.10.77	48	33.7	89.0	0.7	2
14.	2.10.77	48	33.8	86.0	2.6	2
15.	9.10.77	55	31.0	75.0	0.3	2
16.	11.10.77	57	33.8	81.0	0.7	2
17.	11.10.77	57	34.0	78.0	1.6	2
18.	13.10.77	59	36.2	83.7	1.6	2
19.	13.10.77	59	33.6	81.0	1.75	3
20.	13.10.77	59	34.0	83.0	1.8	3
21.	13.10.77	59	35.0	84.2	2.0	3
22.	13.10.77	59	36.1	86.0	2.0	3
23.	13.10.77	59	35.6	84.0	2.2	3
24.	13.10.77	59	35.6	87.4	2.8	3
25.	15.10.77	61	34.0	76.0	4.0	3
26.	15.10.77	61	35.6	86.0	4.4	3
27.	15.10.77	61	37.0	88.2	5.4	3
28.	15.10.77	61	33.9	78.0	6.7	3
29.	15.10.77	61	35.5	82.2	6.6	2
30.	15.10.77	61	34.6	87.0	7.2	2
31.	18.10.77	64	35.4	84.0	*	1
32.	22.10.77	68	35.8	86.8	4.5	3
33.	25.10.77	71	37.0	97.0	0.45	2
34.	25.10.77	71	36.8	94.0	0.4	2
35.	4.11.77	81	37.6	112.0	6.0	3
36.	8.12.77	115	39.2	118.0	*	1

* Nest site not located so distance moved cannot be calculated.

TABLE 3

CAPTURE DATA ON WILD HATCHLINGS DURING 1978

No.	Date of collection	Age (days)	Length (cm)	Weight (g)	Distance moved from the nest (km)	Attributable to nest numbers
1.	18.9.78	34	29.2	75.2	0.15	2
2.	18.9.78	34	28.5	74.0	0.2	2
3.	18.9.78	34	29.0	77.0	0.3	2
4.	19.9.78	35	29.7	77.2	0.5	2
5.	20.9.78	36	28.5	76.0	0.45	2
6.	20.9.78	36	29.0	71.0	0.4	2
7.	20.9.78	36	29.4	74.0	0.2	2
8.	20.9.78	36	27.8	74.5	0.3	2
9.	24.9.78	40	28.5	73.0	0.8	2
10.	24.9.78	40	29.1	74.5	0.7	2
11.	24.9.78	40	28.6	80.0	1.64	3
12.	2.10.78	48	28.0	67.0	1.0	2
13.	5.10.78	51	28.0	73.5	1.1	2
14.	5.10.78	51	28.4	76.5	1.2	2
15.	14.10.78	60	29.2	82.0	1.0	2
16.	14.10.78	60	28.6	73.8	1.25	2
17.	14.10.78	60	27.7	68.0	1.0	2
18.	18.10.78	64	32.8	84.0	3.5	3
19.	18.10.78	64	33.2	83.0	4.0	3
20.	26.10.78	72	34.0	79.0	4.8	3
21.	5.11.78	82	34.3	80.6	*	1

* Nest site not located so distance moved cannot be calculated.

1975: Four hatchlings were collected from two nests. Nest 1 was located near the head of a tertiary creek. The first hatchling was collected well down the secondary creek 1.0 Km from the nesting site when 39 days old. The second hatchling collected after 57 days, had moved a distance of 2 Km in the same direction but had left the side creek and was in the main Bhitarkanika nalla.

1977: Thirty-six hatchlings were collected, representing three nests, the location of only one of which is known. Data from these nests are presented in Table 2 which indicate the increasing dispersal with time, particularly in the spread of hatchlings. The mean distance moved for 12 hatchlings captured after 45 to 48 days was 1.6 Km., whereas for 16 hatchling collected between 55 and 61 days the mean was 3.2 Km. Only three hatchlings were collected after 70 days (between 71 and 81 days) and the mean for these (2.0 Km). Two showed almost no movement - 0.4 and 0.5 Km - whereas the third had moved 6.0 Km. These data are shown roughly in Table 2.

1978: Twenty-one hatchlings were collected, representing definitely two and probably three nests. Those hatchlings located between 34 and 36 days (8) were all close to the nest(s) and the mean distance moved was 0.3 (range 0.15 - 0.5 Km). Subsequent captures were much more spaced out as noted above for 1975 and 1977. Six individuals captured after 60 - 72 days showed a mean dispersal of 2.6 Km., range 1.0 - 4.8 Km. (Table 3).

Whereas the four 1975 hatchlings (two each from two nests) showed definite movements downstream towards the main river from the secondary or tertiary creeklets where the nests were located, the 1978 hatchlings (21) scattered but appeared to settle in the secondary or tertiary creeks. Only two hatchlings were located in the main Bhitarkanika nallah as against seven in secondary or tertiary creeks (other than the one in which the nest was located) and five in a secondary creek which they had entered by migrating down the nesting creeklet. Only three of these five, however, were collected downstream of the nesting creek.

Growth: The growth data collected by measuring and weighing the wild caught hatchlings at the time of their capture is compared with the growth of hatchlings from the population hatched and reared at Dangmal within the same sanctuary, under similar climatic conditions. The growth data for the three years 1975, 1977 and 1978 is given in tables 1 - 3.

1975: There is limited data on the wild caught hatchlings and the captive hatchlings and the comparison is based on hatchlings from the only nest which were considered to be weak. Accordingly, the wild hatchlings all slightly exceeded the captive individuals in length and subsequently exceeded them in weight.

1977: Captive growth data was based on five nests. The length of captive and wild hatchlings was similar in the period up to the end of October. Weight data indicates that the captive hatchlings were moving ahead of the wild hatchlings by late September and increased this lead markedly thereafter.

1978: Captive growth data were based on hatchlings from four nests. The length of captive reared hatchlings exceeded those from the wild from the start of September and increased their lead until mid October. Four individuals captured in the second half of October and start of November, however, were only slightly shorter than wild hatchlings. The difference in weight was also well marked throughout with the captive hatchlings being substantially heavier.

DISCUSSION

Dispersal of the hatchlings from the tertiary or secondary creeks into the primary creek or the main river, is influenced by the following factors:

a) *Passage of time*: This can be seen from the Tables. The hatchlings gradually spread out over a period of several months.

b) *Tidal influences*: There is the normal two complete tide cycles per day in Bhitarkanika and the effects of these undoubtedly assist the dispersal.

c) The peak annual rainfall occurs in July with resultant flooding the following month. Rainfall and flooding however, occurs at least until 15th November by which time the hatchlings are 3 months old.

Unless each nest under collection at the time of laying is located subsequently, it is not possible to know the exact number of hatchlings which emerge from the nest (see below).

Growth: In 1975 the growth of the wild hatchlings was marginally better in length and substantially better in weight than those reared in the Centre. However, only four wild hatchlings were captured in September and October and the captive husbandry data is based on twenty-five hatchlings resulting from a single nest. The 1977 data for length shows that the captive hatchlings grew at least as well as the wild hatchlings (note the scatter of the latter above the former during late September and October). The data for weight, however, indicates that the captive hatchlings were heavier from the end of September and these differences in weight had increased greatly.

In 1978 the captive hatchlings were greater in length than most of the wild hatchlings from September in contrast to 1975 and 1977. However, as in 1977, crocodiles can be grown much more rapidly in captivity than they would in the wild. It is interesting to note that the difference can occur so markedly in extremely small hatchlings under captive conditions. Food supply is of course much better under captive conditions and although food is abundant in Bhitarkanika, its availability to the hatchlings is limited and the hatchlings vary in ability to capture it.

The hunting effort was not the same for all years. In 1975 there were very limited attempts to collect wild hatchlings. In the tertiary or secondary creeks, it is easy to collect the hatchlings as there is minimum scattering due to restricted tidal influence. This task becomes more difficult in the larger primary creeks and main river systems. The Dhamara river is the largest river within the sanctuary. The poor survival record here is thought to be due to high tidal influences, particularly fast currents and human disturbance such as fishing. In the main Bhitarkanika river, survival is also less satisfactory and the secondary spread of the hatchling crocodiles in a number of primary creeks associated with the main river posses problems for collection. It is thought that predation on hatchlings is much greater in the major rivers than in the tertiary or secondary creeks.

Management implications : In view of the markedly different early survival rates of wild and captive reared hatchlings in the first few months of life, every effort should be made to locate all nests as quickly as possible after laying for hatchery incubation. Loss at the Centre after the initial month are extremely low whereas it is considered likely that these losses continue at a high level in nature.

In the event that some nests are not located, efforts should be made to collect the wild hatchlings immediately after hatching to minimise loss.

Strenuous efforts should be made to locate all nests missed at the time of egg collection to improve the research base. It is important to know the location of the nest and the nest contents should be examined in order to confirm the number of hatchlings which emerge from the nest and also to check on the number of unhatched infertile eggs. Where this information is available it is possible to work out the exact loss on a nest by nest basis.

Prevention of disturbances in the creek system where hatchlings occur is the main management objective. The present ban on the use of gill nets for fishing must remain in force.

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NEW DESCRIPTIONS

A NEW SPECIES OF THE GENUS *ERGASILUS* NORDMANN, 1832 (COPEPODA: POECILOSTOMATOIDA) FROM KERALA[1]

SHAJU THOMAS[2]

(With twelve text - figures)

Ergasilus vembanadensis sp.nov. collected from the gills of *Wallago attu* (Bloch & Schneider) is described and illustrated.

INTRODUCTION

The family Ergasilidae has more than 100 species, which parasitise mainly freshwater and marine teleost fishes (Kabata 1979). Adult females of the genus *Ergasilus* are usually attached to the body surface or on the gills of the fishes whereas males remain free-swimming throughout their life. In the oriental region this genus has not been studied in detail (Fernando and Hanek 1973). Karamchandani (1952) had given a key to the seven species of *Ergasilus* described from Indian waters. A new species is described here.

Ergasilus vembanadensis sp. nov.

MATERIAL: Twenty females were collected from the gills of *Wallago attu* caught from the Vembanad lake, Kerala. The holotype female will be deposited in the Indian Museum, Calcutta, India.

FEMALE (Fig. 1) : Cephalothorax is longer than wide and subtriangular. Cephalic fusion with the first thoracic segment is marked by a dorsal groove. Cephalon broader at the region of fusion and provided with a pair of distinct dorso-lateral setules. Second to fifth leg - bearing segments gradually diminishing in size posteriorly. Genital segment is barrel-shaped with several rows of fine spinules ventrally. Abdomen three-segmented, each segment bearing a row of fine spinules ventrally near the anterior margin (Fig. 12). Uropod squarish with a long medial seta.

First antenna (Fig. 2) is six-segmented, basal segment broader than long, second segment stout and thick, succeeding segments decreasing in size and each segment bears numerous simple setae of varying length. Second antenna (Fig. 3) is four-segmented, basal segment is short and stout, second segment longer than the first with a sensillum on the distal half of the medial margin, third segment slender and curved. Distal segment is a sharp and strong claw. Mandible (Fig. 4) is indistinctly two-segmented. Basal segment is massive, the mandibular palp, with hairs on its inner margin, is present at the distal end. The distal segment bears a papilla, from which arises a terminal spine beset with hairs. Posterior to the spine a large falciform blade is present which is ventrally fringed with hairs. The base of the distal segment has an elongated spine with fine hairs. First maxilla (Fig. 5) is round in shape, armed with two long subequal setae. Second maxilla (Fig. 6) is two segmented, basal segment broad and thick, distal segment is thickly packed with denticles. Maxilliped is absent.

First to fourth thoracic appendages are biramous and have two-segmented sympod. Coxa is devoid of ornamentation while basis has a plumose seta on the lateral margin and fine spinules on the distal inner margin. All setae on the appendages are plumose. First leg (Fig. 7): exopod is three-segmented, basal segment longer than broad with a

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distal spine, the spine and the distal outer margin of the segment are denticulated. Second segment is about half the length of the basal segment with a single seta on the inner margin and a row of denticles on outer margin. Terminal segment is small, bearing two spines with serrated flange and five setae. The inner margin of the first and second segments bear fine hairs. Endopod is three-segmented, basal segment longer than broad with denticles and fine hairs on the outer margin and bears an inner seta. Second segment is similar to the first segment. Distal segment carries two spines with denticular flange and four setae. The outer margin has a row of denticles and fine hairs.

Second leg (Fig. 8): exopod is three-segmented, basal segment long and stout with a distal spine and fine hairs on the inner margin. Second segment is shorter than the basal segment with fine serration on the outer margin. It bears a single seta and fine hairs on the inner margin. Terminal segment is comparatively short, having fine serration on the outer margin and six distal setae. First segment of endopod is long having a single seta. Second and third segments are almost equal in size, second segment with two inner setae and distal segment bears a strong spine and four setae. The outer margin of all the segments have a row of spinules between fine hairs.

Third leg (Fig. 9): exopod is three-segmented, basal segment is longer than the second and third combined together, bears a distal spine and fine hairs on the inner margin. Second segment is short, carries an inner seta and fine hairs on the inner margin. Third segment bears a spine and six setae. Endopod is three-segmented, segments decreasing in length distally. Basal segment with a single seta, second segment bears two setae and terminal segment has one strong spine and four setae. The outer margin of all the segments carry a row of spinules between the fine hairs.

Fourth leg (Fig. 10): exopod is two-segmented, basal segment long and stout with distal spine, second segment short, bears one spine and five setae distally. Endopod is three-segmented, segments subequal in length, first with a single seta, second with two setae and third carries one strong spine and three setae. The outer margins of all the segments carry fine hairs.

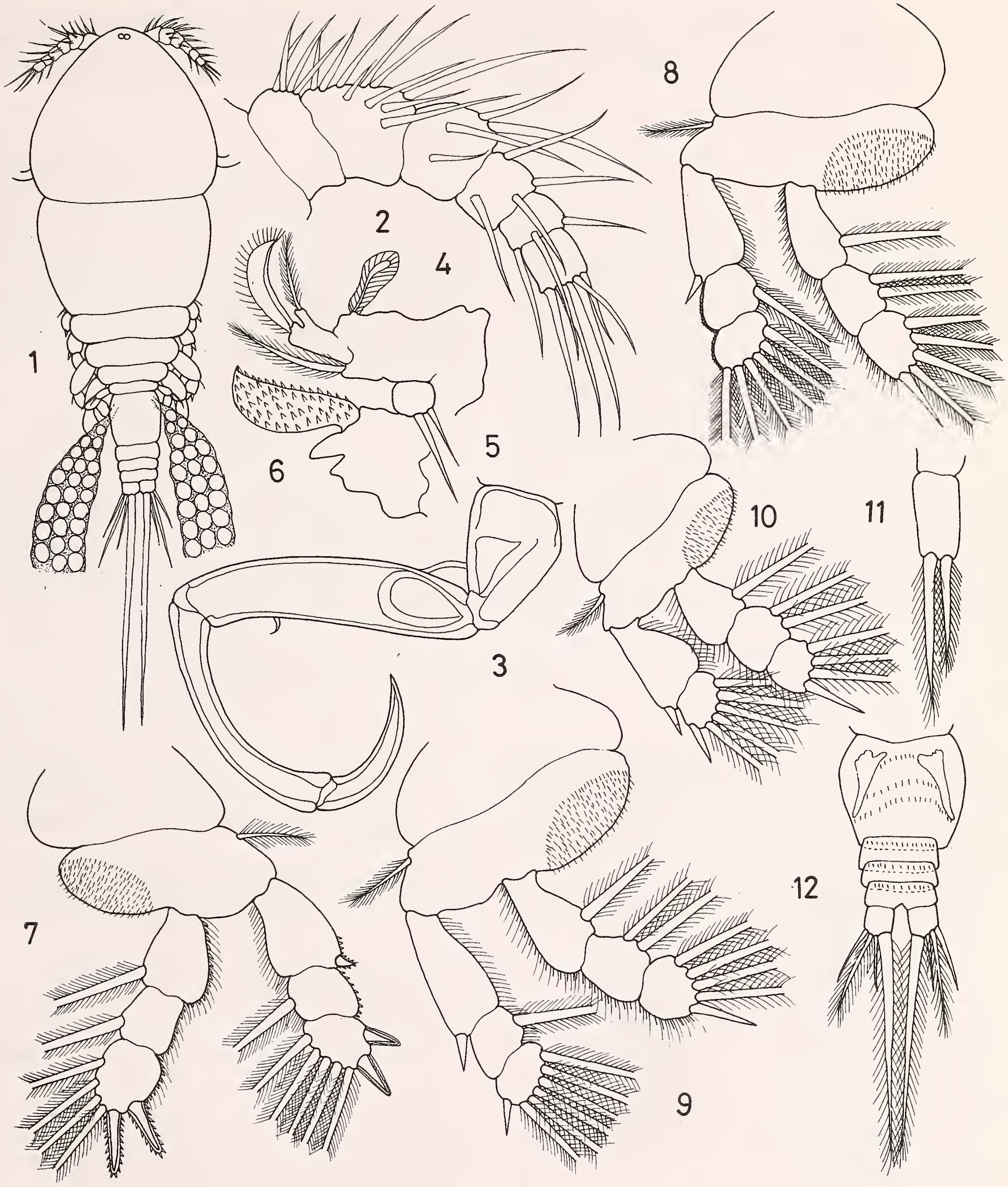
Fifth leg (Fig. 11): single segmented, longer than broad with two subequal distal setae.

Uropod (Fig. 12): squarish with an elongated medial seta and a short lateral seta between two spiniform setae. Total length: 0.8-0.9 mm.

MALE : Unknown.

This species has been named after the collection locality, Vembanad Lake.

Remarks: *Ergasilus vembanadensis* sp. nov. resembles *E. ceylonensis* Fernando and Hanek, in its general body shape. In both species, the cephalothorax is subtriangular and indented mid-dorsally. Genital segment is barrel - shaped and slightly wider than the fifth segment in both species. But *E. vembanadensis* differs in many respects from *E. ceylonensis*. In *E. vembanadensis* the caudal ramus is squarish whereas in *E. ceylonensis* it is slender and long. Though the first antenna is six-segmented in both species, in *E. cyelonensis* the first segment is long, contrary to the broad first segment of the present species. Second antenna also exhibits differences in both the species. Sensillum is absent on the second antenna in *E. cyelonensis,* whereas it is present on the second segment in the new species. Mouth parts and thoracic appendages of both these species are not similar. the exopod of fourth leg is three-segmented in *E. ceylonensis* whereas in *E. vembanadensis* it is two-segmented as in the case of several *Ergasilus* species.



Figs. 1 - 12. *Ergasilus vembanadensis* sp.nov.
1. Female ; 2. First antenna ; 3. Second antenna ; 4. Mandible ; 5. First maxilla ; 6. Second maxilla ;7. First leg ; 8. Second leg ; 9.Third leg ; 10. Fourth leg ; 11. Fifth leg ; 12. Genital segment, abdomen and uropod.

Ergasilus scotti Sundara Raj (1923) and *Ergasilus bengalensis* Southwell and Prasad (1918) are other *Ergasilus* sp. reported from *Wallago attu* in Indian waters. Though the new species is from the same host, these species are quite different in morphology and structural details.

The cephalothorax of *E.scotti* is violin-shaped and in *E.bengalensis* it is more or less elliptical, Whereas in *E. vembanadensis*, the cephalothorax is subtriangular and indented. Sensillum is absent on the second antenna of *E. scotti* and *E. bengalensis* but it is present on the second segment of the second antenna of the new species. Mouth parts and thoracic appendages of *E. vembanadensis* are different in structural details from *E. scotti* and *E. bengalensis*. Uropod of *E. scotti* bears three long setae and *E. bengalensis* carries two setae whereas in the present species uropod is with an elongated medial seta in addition to a short lateral and two spiniform setae. The fifth leg in *E. scotti* is much reduced, papillaeform with two spines and in *E. bengalensis*, it is knob like with single spine. But in *E. vembanadensis* fifth leg is longer than broad with two subequal distal setae.

E. vembanadensis sp. nov. can be distinguished from all other species of the genus by the presence of paired dorso-lateral cephalothoracic setules, denticulation of the second segment of second maxilla, sensillum on second antenna, ornamentation and armature of thoracic appendages, single segmented fifth leg with two setae, and the spiniform setae on the uropod.

ACKNOWLEDGEMENT

I record my gratitude to Dr. M. Shahul Hameed, Professor, Department of Industrial Fisheries, Cochin University of Science and technology, Cochin, Kerala for the encouragement and helpful guidance rendered during the course of this study.

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A NEW SPECIES OF *LABIDOCORIS* MAYR (HETEROPTERA: REDUVIIDAE: ECTRICHODIINAE) FROM SOUTH INDIA[1]

Dunston P. Ambrose and S.J. Vennison[2]

(With sixteen text-figures)

Introduction

Labidocoris Mayr is a little known genus in the subfamily Ectrichodiinae of the family Reduviidae. Distant (1902) has included only one species, namely *Labidocoris elegans* Mayr in his *Fauna of British India* Caprile*s* (1990) also listed only one species of *Labidocoris,* namely *Labidocoris elegans* Mayr (*Cimbus elegans* Walker) from Indian faunal limits and another two species viz. , *L. insignis* Distant from Japan and *L. pectoralis* (Stål) from China. The present study adds one more species to this small genus. The new species is assigned to the subfamily Ectrichodiinae by the presence of broad scutellum with two apical spinous angulations and to the genus *Labidocoris,* because of the following taxonomic characters, such as seven jointed antennae, anterior femora strongly tuberculate near apex, profoundly sulcate anterior lobe of pronotum with two minute discal tubercles.

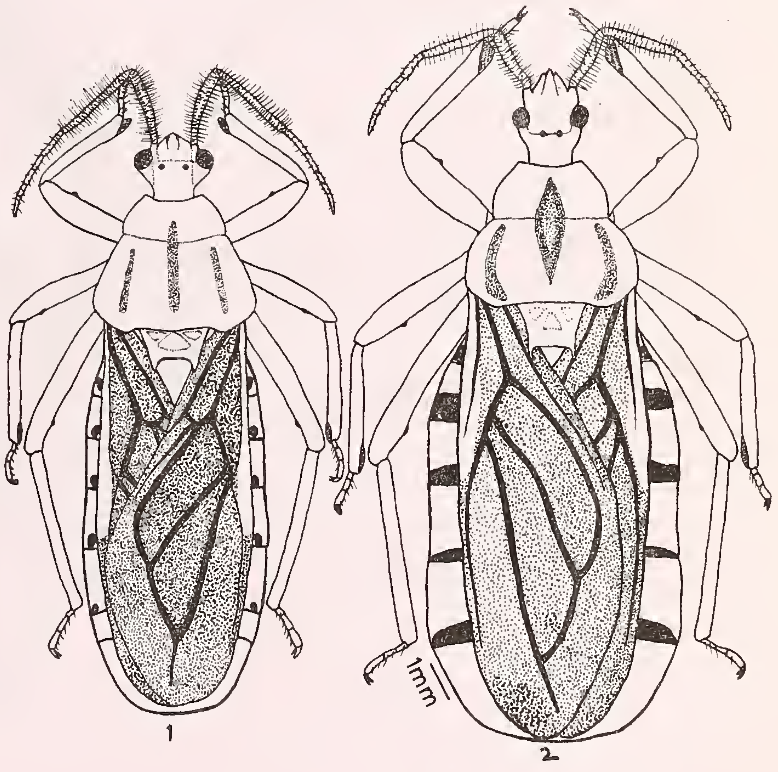
Labidocoris tuberculatus sp. nov. (Figs. 1 - 16)

Total length 14.5 mm, width across the eyes 1.75 mm; across prothorax 3 mm.

Coral red, antenna except terminal segments, eyes, lateral and ventral pterothorax, clavus, membrane connexival spots, lateral fasciae of abdominal segments and genital segment black.

Head length 2.5 mm; width 1.75 mm (Figs. 3 and 4) transverse immediately behind compound eyes; postocular portion slightly raised compound eyes slightly protruded antero-laterally, two black transparent ocelli located at the slightly raised portion of the postocular area, rostrum, (Fig. 4) 2.2 mm long slightly curved, 2nd rostral segment the longest and robust; antennae (Fig. 5) (7.65 mm long) 7 segmented, outwardly deflexed, pedicel the longest; scape and pedicel covered with short stout bristles; an intercalary segment in between pedicel and 1st flagellar segment; antenniferous tubercles prominent, neck distinct.

Pronotum (Fig. 3) (3 mm long; 4 mm broad) shining, polished and transversely divided before the middle and centrally strongly grooved, posterior lobe of pronotum laterally grooved on each side; antero-lateral pronotal angles obtuse and posterolateral pronotal angles rounded, disc of



Figs. 1-2. *Labidacoris tuberculatus* sp. nov.
1. Male and 2. Female : dorsal view.

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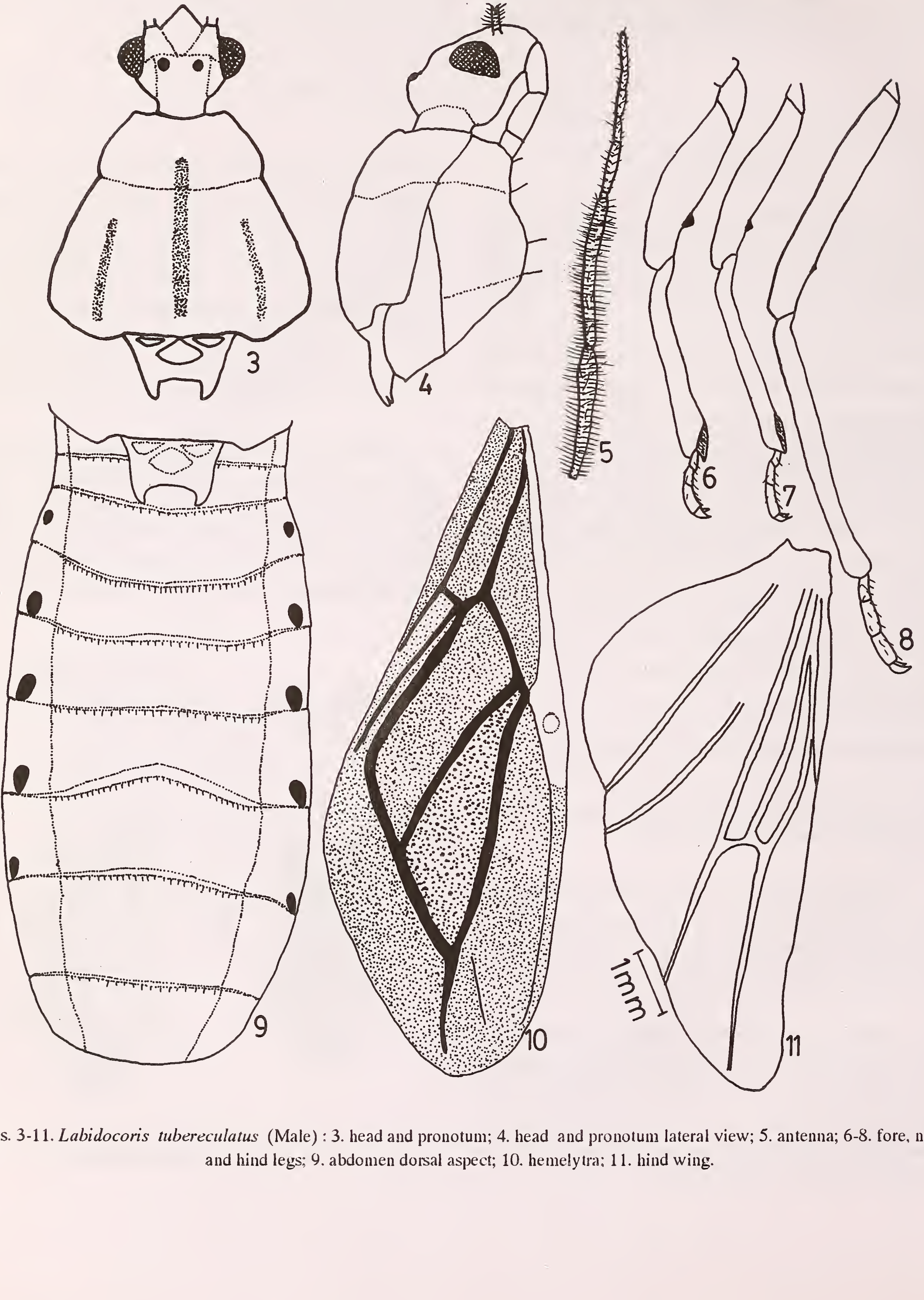


Figs. 3-11. *Labidocoris tubereculatus* (Male) : 3. head and pronotum; 4. head and pronotum lateral view; 5. antenna; 6-8. fore, mid and hind legs; 9. abdomen dorsal aspect; 10. hemelytra; 11. hind wing.

scutellum concave and its apex biangulate and wide apart (Fig.3); apices of fore femora (Fig. 6) strongly and intermediate and hind femora moderately tuberculate beneath with a tubercle; hind legs (Fig. 8) the longest, middle legs (Fig.7) the shortest; fore and mid tibiae bear apical spongy fossula; hemelytra (Fig. 10) (8.5 mm long; 3.5 mm broad) not reaching the abdominal apex.

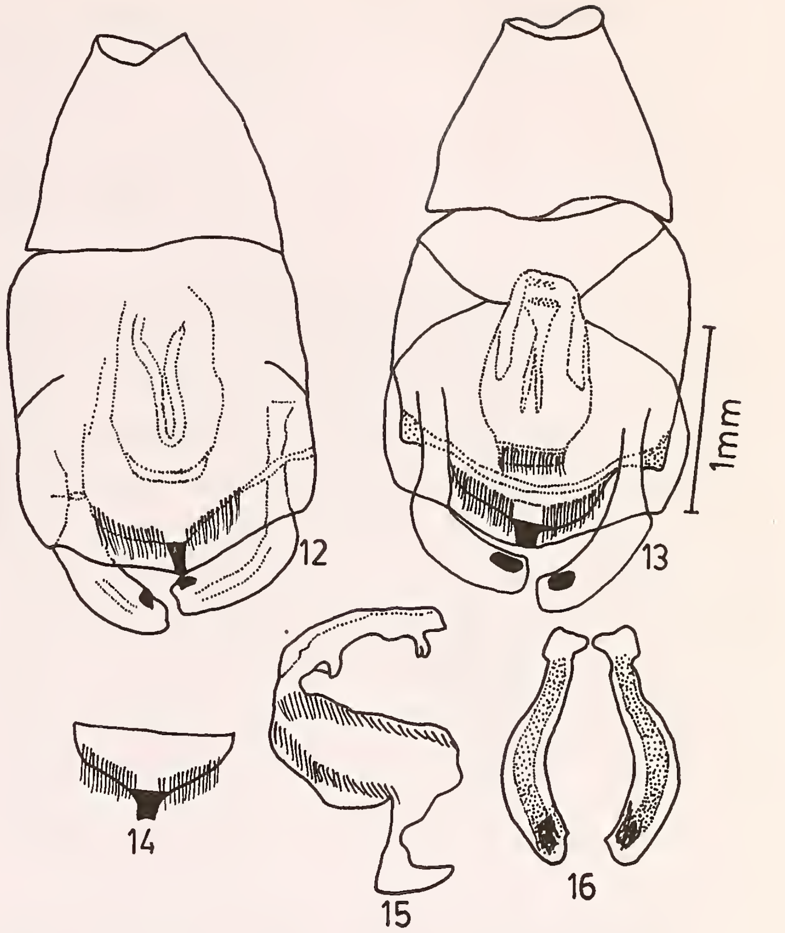
Abdomen (Fig. 9) (9.0 mm long ; 4. 0 mm broad) elongately oval; 5 pairs of connexival spots prominent.

Genitalia as in figures 12-16. Pygophore more or less rectangular, its apex rounded. Phallus more or less 'S' shaped and the parameres a little elongated and sickle shaped. Female (Fig. 2) larger than male.

L. tuberculatus sp. nov. is allied to *L. elegans.* But *L. tuberculatus* sp. nov. can be distinguished from *L. elegans* by its large size (14.5 mm long and 4. 0 mm broad) and the strongly tuberculate apices of fore femora.

Holotype: Male, collected from Courtallam tropical rain forest, Nellai Kattabomman District, Tamil Nadu, India altitude 280 m(8° 56' N and 77° 16'30 E) collecdted by S. John Vennison on 10.vii.1990. The holotype is deposited in the Insect collection (No.6), Entomology Research Unit, St. Xaviers (Autonomous) College, Palayankottai, India.

Allotype: Female, collected from the same locality.



Figs. 12-16. *Labidocoris tuberculatus* Male genitalia : 12. pygophore dorsal view; 13. pygophore ventral view; 14. strut; 15. phallus and 16. parameres.

Etymology: The species is named *Labidocoris tuberculatus* due to the presence of tubercles in the fore femorae.

ACKNOWLEDGEMENTS

We are grateful to Rev. Fr. Dr. S. Ignacimuthu, S. J., Principal and Rev. Fr. Stephen T. de Sousa, S.J., Head of the Department of Zoology, St. Xavier's (Autonomous) College, Palayankottai for facilities and encouragement. The financial assistance from the Council of Scientific and Industrial Research, New Delhi is gratefully acknowledged.

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A NEW SPECIES OF *CORANUS* CURTIS FROM SOUTH INDIA (INSECTA - REDUVIIDAE - HARPACTORINAE)[1]

Dunston P. Ambrose and K. Sahayaraj[2]

(With sixteen text - figures)

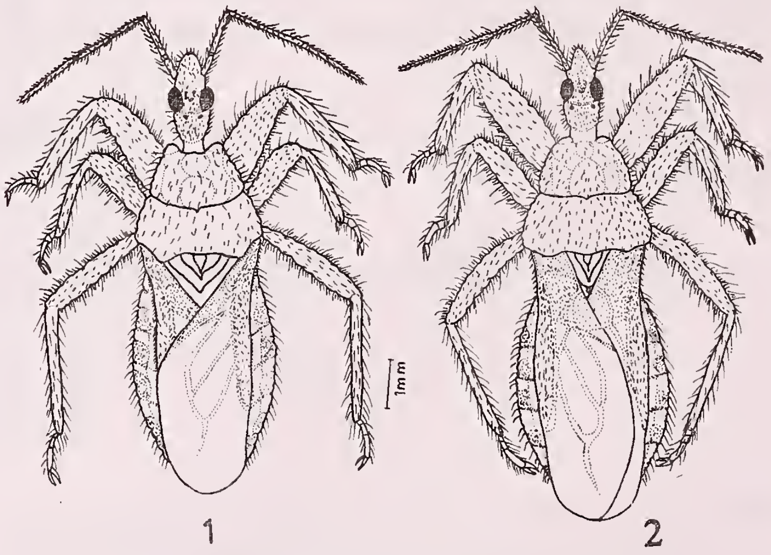
Distant (1902) described six species of *Coranus* Curtis in his Fauna of British India. Capriles (1990) listed six species of *Coranus* , namely *C. militaria* Distant; *C. niger* (Rambur); *C. siva* (Kirkaldy); *C. spiniscutis* Reuter; *C. vitellinus* Distant and *C. wolffi* Lethierry and Severin (*Reduvius aegyptius* Wolff) from Indian faunal limits. Ambrose (1980) redescribed *Coranus vitellinus* Distant and Ambrose & Vennison (1989) described a new species *Coranus soosaii* from South India. In the present paper a new species of *Coranus* is described and illustrated.

Coranus nodulosus sp. nov. (Figs. 1-16)

Total length 8.72 mm; width across compound eyes 1.0 mm; across prothorax 1.94 mm and across the abdomen 2.86 mm (Fig. 1). Piceous; antennae (except 4th segment), tibiae, tarsi, brown, connexival spots, interior corium fuscescent; head, thorax and abdomen above and beneath bear stramienous fine hairs; head oblong and bulbous, 1.92 mm long and 1.0 mm broad; transverse behind eyes, nodulose anteocular portion twice as long as slightly raised postocular portion, ocelli one on each side located just behind the compound eyes (Figs. 1-3); antennae 3.96 mm long, five segmented antennae inserted just in front of the compound eyes, scape the shortest and not passing the apex of the head, third flagellar segment the longest (Figs. 1, 5); rostrum slightly curved; basal and medial segments almost equal and 3rd segment the shortest; rostral tip touching the prosternal groove (Fig. 4).

Pronotum 2.2 mm long and 1.94 mm broad, unicolourous, nodulose, transversely divided just before middle, longitudinally impressed; anteriolateral angles of the pronotum obtuse and posterolateral angels of pronotum rounded (Figs. 1-3). Scutellum triangular with an erect conical tubercle; fore femora slightly incrassated and swollen, mid femora the shortest and hind femore the longest; tarsi 3 segmented, 1st segment the shortest and 3rd the longest; tibiae devoid of tibial pads but with tibial combs (Figs. 1, 5-7); hemelytra 4.96 mm long and 1.83 mm broad, slightly passing the abdominal apex, venation of hemelytra and hind wings as in figures 1, 8 and 9. Abdomen 4.80 mm long and 2.86 mm broad, nodulose segmental sutures prominent; elongately oval, connexivum narrow and spotted (Figs. 1, 9). Last abdominal segment bears a pair of conspicuous piceous spots. Genitalia as in Figs. 11-16.

Female has longer anteocular (1.14 mm) and postocular areas (0.89 mm), distance between the eyes (0.56 mm), antennae (4.13 mm), rostrum (2.12 mm), fore, mid and hind legs (1.85, 1.73 and 2.68 mm, respectively), longer abdomen (5.42 mm) and



Figs. 1-2. *Coranus nodulosus* sp. nov.
1. Male and 2. Female : dorsal view.

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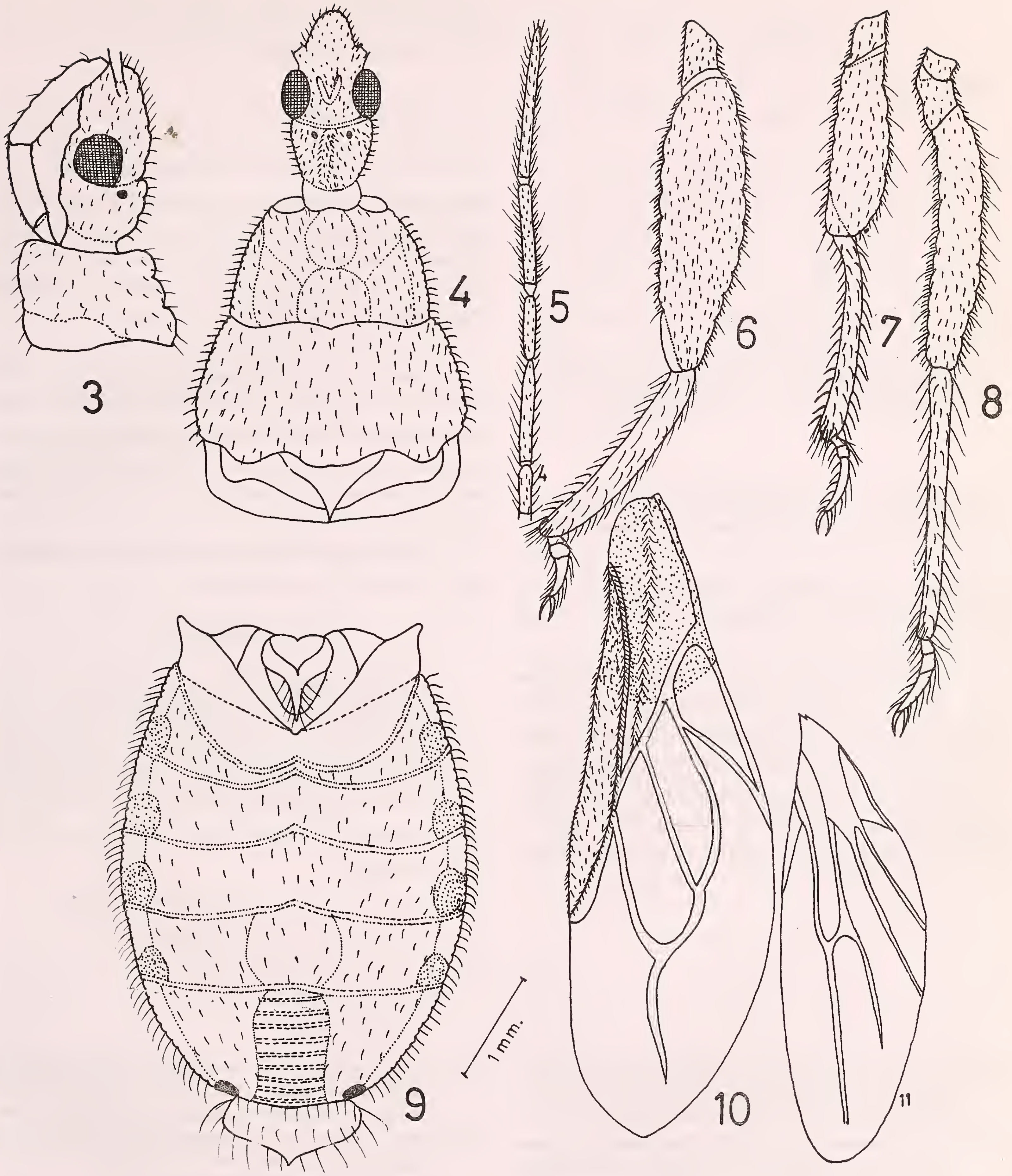
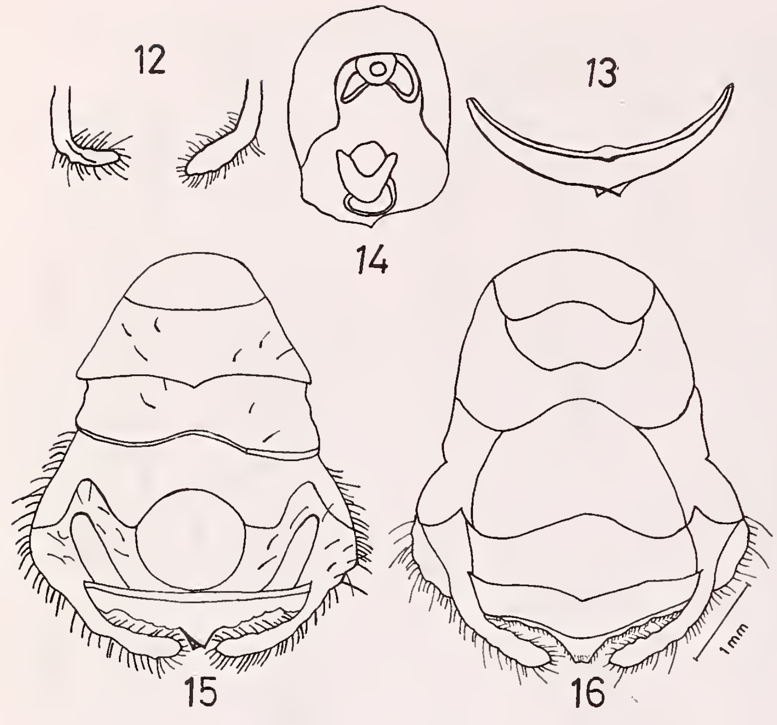


Figs. 3-11. *Coranus nodulosus* sp. nov. (Male) : 3. head and pronotum lateral view; 4. head and pronotum; 5. antenna; 6-8. fore, mid and hind legs; 9. abdomen dorsal aspect; 10. hemelytra; 11. hind wing.



Figs. 12-16. *Coranus nodulosus* sp. nov.
Male Genitalia: 12. pygophore-dorsal view; 13. pygophore-ventral view; 14. strut; 15. phallus and 16. parameres.

hemelytra (5.68 mm) and broader abdomen (3.34 mm) and hemelytra (2.10 mm).

Type information : Holotype : Male collected from a cotton field at Sivanthipatti, Nellai Kattabomman district, Tamil Nadu, India (altitude 125.33 ± 2.87 m, 8° 30' N, 77°47' E) by Sahayaraj on 4. iii. 1990. The holotype is deposited in the Insect collection (No. 7), Entomology Research Unit, St. Xavier's College, Palayankottai, India. The allotype and paratypes (one male and two females) were collected from cotton fields in and around Sivanthipatti by Sahayaraj on 25. iii .1990.

Affinity: *C. nodulosus* sp. nov. is closely related to *C. soosaii* in having five segmented antenna and scape and 3rd flagellar segment as the shortest and the longest antennal segments, respectively; slightly curved rostrum, with almost equal first and second segments and third the shortest segment; pronotum transversely divided before the middle; scutellum triangular.

However, *C. nodulosus* sp. nov. can be easily differentiated from *C. soosaii* by the slightly raised postocular area, unicolourous pronotum, pale brown corium and brown tibiae; oblong head, longer anteocular (twice as postocular), nodulosus head, prosternum and abdomen.

Etymology: The species is named *C. nodulosus* from its nodulose appearance.

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We are grateful to Rev. Fr. Dr. S. Ignacimuthu, S.J., Principal and Rev.Fr.Stephen T.de Souza, S.J., Professor & Head, Department of Zoology, St. Xavier's College (Autonomous), Palayankottai for facilities. The financial assistance from Ministry of Environment & Forest, New Delhi is gratefully acknowledged.

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A NEW SPECIES OF *PERIONYX* PERRIER (MEGASCOLECIDAE, OLIGOCHAETA) FROM NORTHWEST HIMALAYA, INDIA[1]

J.M.Julka And R.Paliwal[2]

(With a text-figure) .

The genus *Perionyx* is endemic to the Indian subcontinent. It comprises 53 species including the common Indian compost worm *Perionyx excavatus* Perrier which is recommended for vermiculture because of its efficacy in degrading various organic waste materials like cow dung, sewage sludge, crop straw, etc. Most of the species are confined to sites with high organic matter and moisture. *Perionyx* is believed to have evolved so long ago in the Indian Peninsula that time was available for its migration to Sri Lanka before the latter was separated, and for its penetration into the eastern Himalaya and Burma across the Rajmahal-Garo Gap (Gates 1972). Species explosion occurred in the eastern Himalaya, a region with considerable and regular rainfall and high organic matter in the soil. The genus is poorly represented in the northwest Himalaya. Only two endemic species, *P. bainii* Stephenson and *P. simlaensis* (Michaelsen), both from Himachal Pradesh occur in the northwest Himalaya (Stephenson 1923). The present paper describes one more new species, *Perionyx barotensis*, from this region.

Perionyx barotensis sp.nov.

Description: Length 71-95 mm, diameter 2.5-3 mm, 105-130 segments. Prostomium epilobic, tongue open. First dorsal pore at 4/5, 5/6. Clitellum annular, xiii-xvii, xviii. Setae perichaetine; *aa*=1.2-1.8*ab*=1.2-1.8*bc*=0.7-1.5*yz*=0.5-1.1*zz* on xii, *aa*=1.1-1.8*ab*=1.3-1.8*bc*=0.5-1.0*yz*=0.4-0.7*zz* on xxiv; 39-51 on ii, 48-57 on vii, 53-59 on xii, 42-62 on xx, 5-6 between spermathecal pore lines on vii, 6-8 between male pore lines on xvii. Male genital area on xviii, transversely elliptical, extending laterally to setae *gh*; combined male and prostatic pores minute, at centres of paired concave furrows, in line with *cd*, 0.06-0.08 body circumference apart. Female pore minute, single and median on xiv. Spermathecal pores paired, minute in 7/8/9 at *c* lines, 0.06-0.07 body circumference apart. Nephridiopores inconspicuous, irregularly alternating between mid-dorsal and mid-lateral lines (as determined internally).

Pigmentation red. Septa 4/5-6/7 delicate, 7/8-12/13 slightly muscular. Oesophagus with a small and slightly muscular gizzard in v, enlarged and moniliform in xi-xiii internally with uninterrupted longitudinal whitish (calciferous) ridges; intestine begins in xvii; typhlosole absent. Dorsal blood vessel single and complete; supra-oesophageal vessel single in x-xiii; extra-oesophageal vessels paired, v-xiii, one vessel joins subneural trunk and the other passes to parietes; subneural bends laterally in xiii and turns up along anterior face of septum 13/14 to join an extra-oesophageal, a thin vessel from subneural extends anteriorly over a few segments beneath the nerve cord; lateral hearts originating from supra-oesophageal vessel with delicate connectives to dorsal vessel in x-xiii, last pair of hearts in xiii. Holandric; testes and male funnels free, in x and xi; seminal vesicles paired, in xi and xii. Penial setae median to openings of prostatic ducts, each ornamented with indistinct broken ridges ectally, 0.29-0.35 mm long, 12-14 μ diameter. Spermathecae paired, in viii and ix, each with a sessile diverticulum at ental end of duct; ampulla irregular in shape; duct shorter than ampulla. Nephridia avesiculate.

Material examined: Holotype: clitellate, Barot, alt.1835 m, 25 July 1992, R.Paliwal; paratypes: 1 juvenile, 2 aclitellates and 3 clitellates with same

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[2] High Altitude Zoology Field Station, Zoological Survey of India, Solan - 173 212 (H.P).

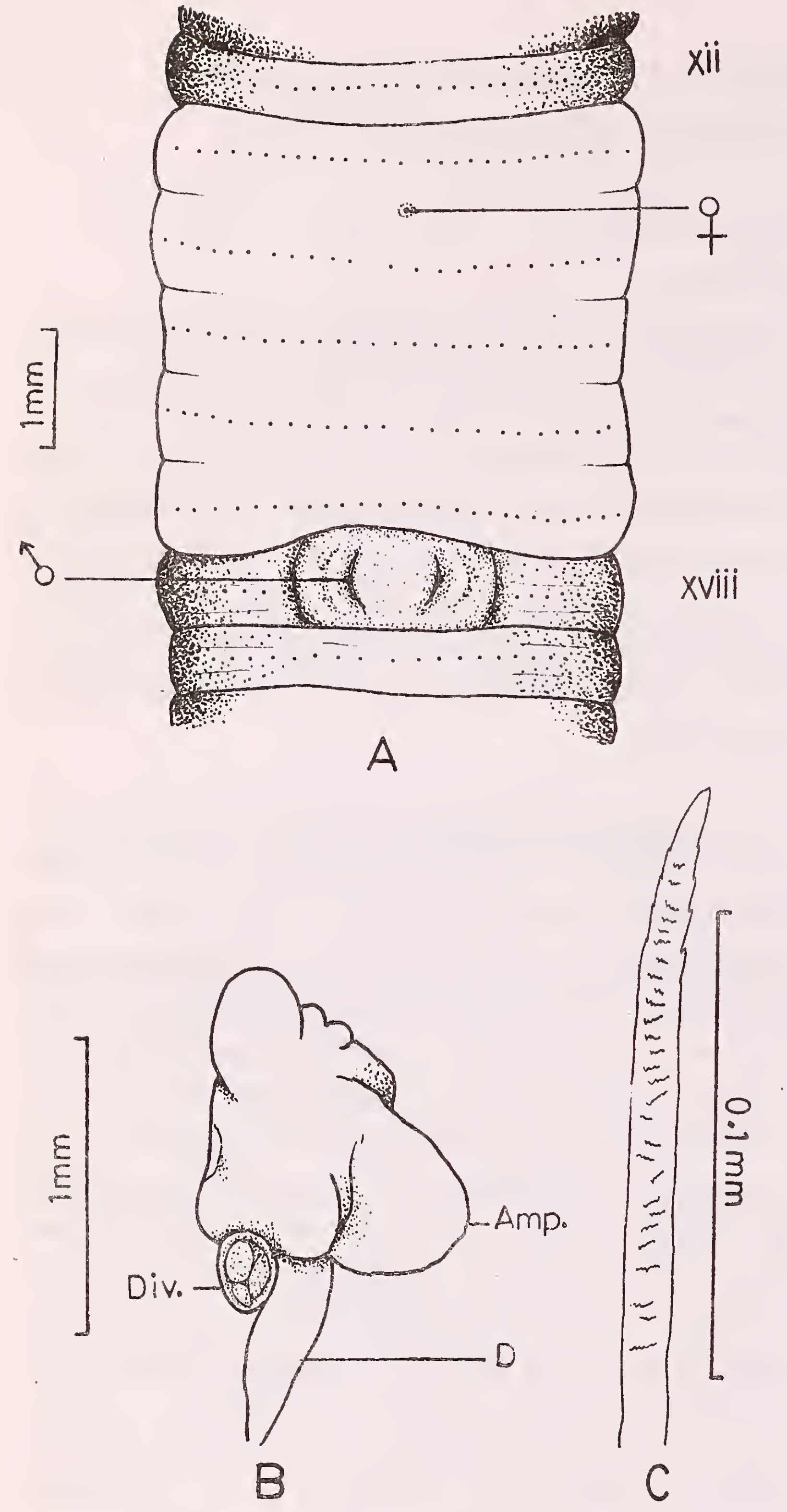

Fig.1. *Perionyx barotensis* sp. nov.
A. Clitellum and male genital area ; B. spermatheca; C. penial seta.

data as for holotype; 1 juvenile and 2 clitellates, Barot, 26 July 1986, J.M.Julka and A.Simonetta. All specimens are in the Zoological Survey of India, Solan (H.P.).

Perionyx barotensis sp. nov. belongs to a group of species with spermathecal pores in intersegmental furrows 7/8 and 8/9. Within this group, it shows closer affinities with a northeast Indian species, *Perionyx fossus* Stephenson, in having little modified penial setae and last pair of hearts in xiii. But it differs by the location of male pores in paired concave furrows, spermathecal pores close to mid-ventral line (0.06-0.07 body circumference apart) and unidiverticulate spermathecae, whereas in *fossus*, male pores are in a single transvers groove, spermathecal pores wider (0.75 body circumference apart) and spermathecae being bidiverticulate. Differences from two northwest Himalayan endemic species under this group are: location of last pair of hearts in xiii as compared to xii in *bainii* and absence of penes which are well developed in *simlaensis*.

The species has been named after the collection locality, Barot.

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INDIAN SPECIES OF THE DELTOCEPHALINE LEAFHOPPER GENUS *SCAPHOTETTIX* MATSUMURA (HEMIPTERA: CICADELLIDAE)[1]

C. A. Viraktamath and G. S. Mohan[2]

(With seventytwo text-figures)

The genus *Scaphotettix* Matsumura is redefined. Its relationship with *Scaphoideus* Uhler, with which it is often confused is discussed. Five new species namely, *Scaphotettix agumbensis* sp. nov. (from Karnataka: Agumbe, Bhagamandala), *Scaphotettix arcuatus* sp. nov. (from Tamil Nadu: Kodaikanal, Shembhaganur), *Scaphotettix freytagi* sp. nov. (from Kerala: Thekkadi; Karnataka: Jog Falls, Mudigere), *Scaphotettix malnadicus* sp. nov. (from Karnataka: Jog Falls) and *Scaphotettix quadrifidus* sp. nov. (from Kerala: Thekkadi) are described and illustrated. *Scaphotettix redundans* (Distant) comb. nov. and *Scaphotettix indicus* (Distant) comb. nov. earlier placed in the genus *Scaphoideus* are also redescribed, illustrated and lectotype designations are made. A key to species of *Scaphotettix* dealt with is also provided.

Introduction

Matsumura (1941) described the genus *Scaphotettix* for the inclusion of *Scaphotettix viridis* Matsumura from Taiwan. To date the genus is known only from the type species and is not recorded outside Taiwan. During revisionary studies on the genus *Scaphoideus* Uhler of the Indian subcontinent, we found a number of species which looked externally like species of *Scaphoideus* but had distinctive fore wing venation and male genitalia. These were later determined as species of *Scaphotettix*. In this paper we redefine the genus *Scaphotettix* and describe five new species from India and transfer two species of *Scaphoideus* described from India to *Scaphotettix*.

The species of *Scaphotettix* were always collected in moist habitats on grasses mixed with herbs. They were most common in areas receiving an annual rainfall of more than 1000 mm.

The depositories of the types of new taxa are abbreviated as follows.

IARI - Indian Agricultural Research Institute, New Delhi, India.

NHM - The Natural History Museum, London, U.K.

NMNH - The National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A.

UAS - The University of Agricultural Sciences, Bangalore, GKVK, Bangalore, India.

Genus *Scaphotettix* Matsumura

Scaphotettix Matsumura, 1914:227. Type species *Scaphotettix viridis* Matsumura, by original designation.

Anterior margin of vertex with one or two marginal and a submarginal inverted V-shaped narrow, chocolate brown to black stripe. Head with one, pronotum with an anterior and a posterior submarginal and scutellum with an anterior broader transverse red, reddish brown or orange bands. Fore wing brownish with transparent spots surrounded by fuscous, veins dark brown.

Head including eyes either as wide as or slightly narrower than pronotum; longer medially than adjacent to eye; either acutely angled or obtusely rounded. Vertex 0.72 times as long as interocular width. Frontoclypeus widened dorsally. Clypellus broadened at apex. Pronotum 0.4 times as long as wide. Claval veins either fused in middle or approximated medially and often connected by a cross vein; a cross vein between outer claval vein and claval suture; anteapical cells three, inner cell open behind, outer one smallest, about 0.5 to 0.66 as long as median anteapical cell; one reflexed vein connecting basal outer angle of outer anteapical cell with costal margin. Fore femora compressed; with a row of stout, short, spines on ventral margin in addition to 10-15 hair-like setae on mesoapical area. Mid femora compressed with a row of some short and some long, stout spines along mesal margin.

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Male pygofer either with or without a process on caudal margin; with tufts of long or scattered setae. Subgenital plates triangular, with rounded apex, with an oblique row of stout setae in addition to long hair-like setae. Style slender, elongate or robust, preapical lobe well developed, ventral area of apophysis serrated. Connective Y-shaped, articulated with aedeagus, without paraphysis. Aedeagal shaft slender, elongate or stouter, wider at base, with or without processes. Gonopore apical or subapical.

First pair of valvulae of female ovipositor with scale-like sculpturing arranged in rows. Second pair of valvulae with 10-17 teeth on cutting edge.

Remarks: *Scaphotettix* resembles some species of *Scaphoideus* externally, namely *S. festivus* Matsumura, *S. consanguineus* Distant, *S. hieroglyphicus* Distant and several undescribed species from India and Sri Lanka. However, *Scaphotettix* is only distantly related to *Scaphoideus* and can be distinguished by the following table of characters.

TABLE

Characters	*Scaphotettix*	*Scaphoideus*
Ratio of width of frontoclypeus at apex to that between antennal base.	0.9 to 1.25	1.32 - 1.68
Claval veins	fused or closely approximated and/or joined by a cross vein	never fused and connected by a cross vein
Reflexed vein in costal area	one	two or more
Paraphysis	absent	always present

KEY TO SPECIES OF *Scaphotettix* Matsumura

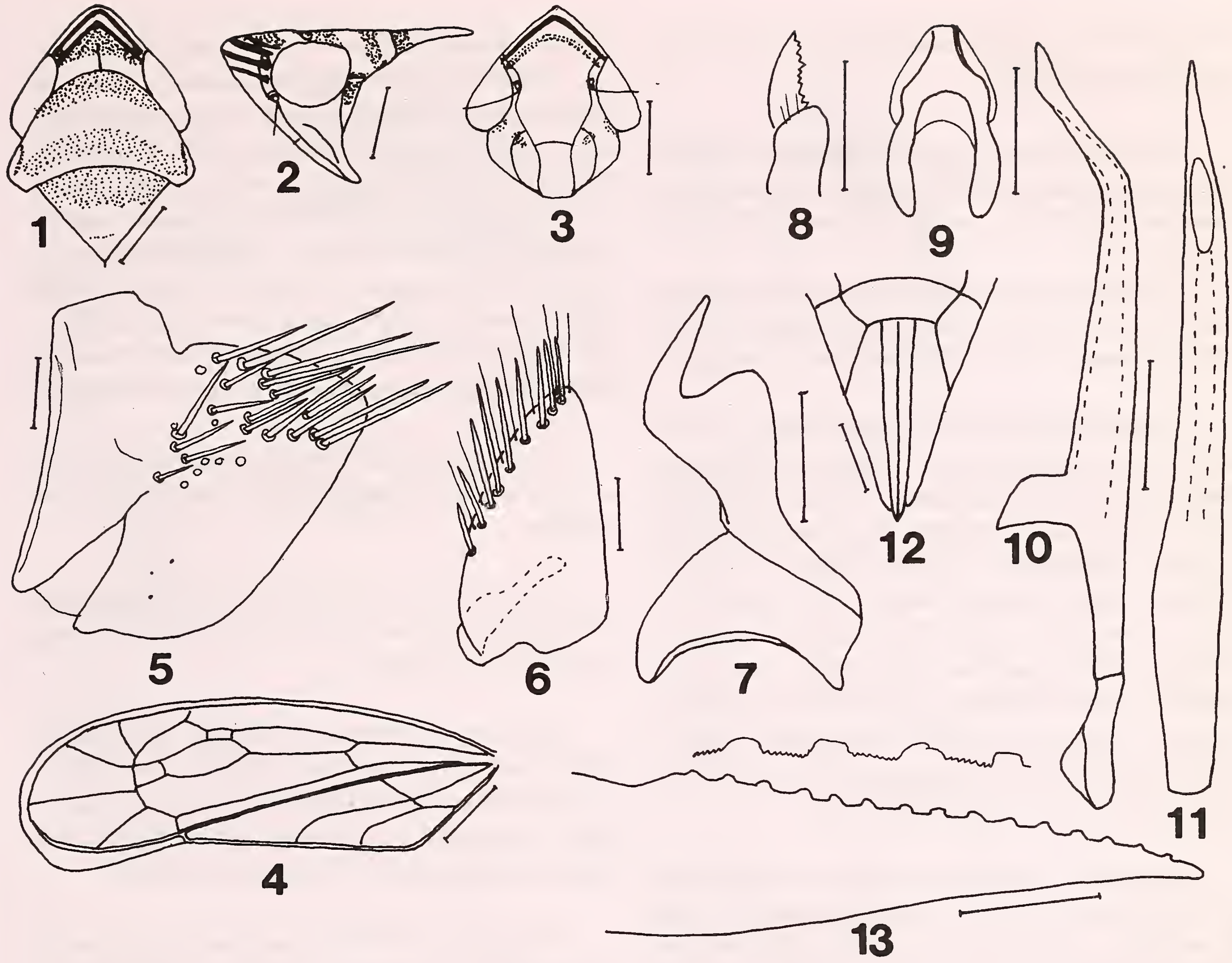
1. Claval veins fused (Fig. 24); aedeagus with apical pair of appendages strongly recurved and directed ventrally (Fig. 29) .... *S. freytagi* sp. nov.
- Claval veins not fused; either approximated and/or connected by across vein (Fig. 4); aedeagus when with appendage not as above 2
2. Male pygofer without a caudal process 3
- Male pygofer with a caudal process (Figs 36, 45, 54, 64) 4
3. Aedeagal shaft straight ; bent dorsally in apical 0.33; without appendages (Fig.10) .... *S. indicus* (Distant)
- Aedeagal shaft strongly, uniformly curved caudodorsally; with a pair of slender, short appendages at apical 0.66 (Fig.19) .... *S. arcuatus* sp. nov.
4. Aedeagus with two pairs of apical appendages (Figs. 69, 70); caudal lobe of pygofer gradually narrowed to an attenuated process, dorsal margin with a short, caudally directed process (Fig. 64) .... *S. quadrifidus* sp. nov.
- Aedeagus with one pair of apical appendages (Figs. 41, 50); caudal lobe of pygofer abruptly narrowed and produced into a spine-like process (Figs. 36, 45, 54) 5
5. Appendages of aedeagus with crenulate margin (Fig. 41); stem of connective more than 1.5 times as long as its arm (Fig. 39) .... *S. redundans* sp. nov.
- Appendages of aedeagus smooth or with single tooth at mid length (Figs 50, 59) ; stem of connective 0.5 times as long as its arm (Fig. 48) 6
6. Aedeagal shaft slender, evenly curved; apical appendage of shaft in caudal aspect L-shaped, with a tooth at midlength (Fig. 50) .... *S. agumbensis* sp. nov.
- Aedeagal shaft stout, wider near base than at apex, appendage of shaft evenly curved ventrally in caudal view(Fig.59) .... S: *malnadicus* sp. nov.

Scaphotettix indicus (Distant) comb. nov.
(Figs. 1 - 13)

Scaphoideus indicus Distant, 1908: 374. Lectotype female, here designated, Burma (NHM, examined).

Scaphoideus festivus sensu Ishihara, 1961: 252, not Matsumura, 1902.

Ochraceous. Markings on head and thorax as described in generic diagnosis. A submarginal longitudinal stripe on extreme lateral area of pronotum fuscous. Dorsal half of episternum and dorsal 0.75 of mesepimeron dark fuscous. Scutellum margined by dark fuscous apically. Fore wing fuscous, venation darker, apex of fore wing broadly



Figs. 1-13. *Scaphotettix indicus* (Distant): 1. Head and thorax; 2. Same, Profile; 3. Face; 4. Fore wing; 5. Male pygofer; 6. Subgenital plate; 7. Style; 8.Apophysis of style; 9. Connective; 10. Connective and aedeagus, lateral view; 11. Aedeagus ventral view; 12. Ovipositor; 13. Apex of second pair of valvula (Scale indicates 0.5 mm in Figs. 1-4 and 12 and 0.1 mm in others).

dark fuscous except hyaline appendix. Legs ochraceous, fore tibiae striped with brown; mid tibiae with three brown spots, basal and median trasomeres of mesothoracic leg brown; apex of hind tibia, basitarsus, entire second tarsomere, basal half of third tarsomere piceous.

Vertex conically produced in front, median sulcus reaching 0.8 length. Pronotum shorter than scutellum. Claval veins approximated and connected by a cross vein, outer anteapical cell 0.5 as long as median cell which is wider in middle.

Male genitalia : Caudal margin of pygofer abtusely rounded with scattered setae, without caudal process, tergum of pygofer well sclerotized. Valve with rounded caudal margin. Style robust, with apophysis laterally directed, with a pointed apex, ventral margin serrate. Stem of connective 0.5 as long as arm. Aedeagus elongate, tubular, preatrium 0.25 as long as total length, dorsal apodeme short, stout; shaft tapered caudally, curved abruptly dorsally at apical 0.33, apex compressed, blade-like. Gonopore subapical.

Female genitalia: Seventh sternum as long as sixth, caudal margin rather straight. Second pair of valvulae with 15 teeth, margin between teeth finely serrate.

Measurements: Male 4.30 to 4.60 mm long, 1.20 to 1.25 mm wide across eyes. Female 4.60 to 4.70 mm long, 1.25 to 1.30 mm wide across eyes.

Material examined: Lectotype female, "Type, H.T. (on red bordered disc)" "*Scaphoideus indicus* Distant, type" "Myitta, Doherty" "Distant Coll. 1911-383" here designated (NHM). Paralectotype female "Assam, Margherita" "Distant Coll. 1911-383" (NHM). *Other material:* INDIA: Uttar Pradesh: 3 males, 5 females, Dehra Dun, 28.iv.1975; West Bengal: 1male, Calcutta, 11.xi.1981; 3 males, 2 females, 10 km N. Siliguri, 1.i.1981; Kerala: 1female, Walayar Forest, 26.x.1975; Karnataka: 1male, Bannerghatta (24 km S. Bangalore), 9.viii,1979, all collected by C.A. Viraktamath (UAS).

Remarks: *S. indicus* is unique among species of *Scaphotettix* in not having aedeagal shaft appendages. Its wings are much darker than in known species of *Scaphotettix*. Ishihara (1961) misidentified this species as *Scaphoideus festivus* Matsumura as is evident from his excellent figures.

Scaphotettix arcuatus sp. nov.
(Figs.14 - 20)

Lateral margin of pronotum with a fuscous line. Proepimeron fuscous. Apices of claval veins dark brown, much broadly so on inner claval vein; clavus with three large whitish hyaline spots; veins marked with dark brown; apices of fore wings hyaline except submarginal narrow fuscous band along marginal vein. Legs as in *S. indicus.*

Head obtusely rounded, interocular width 1.49 as wide as median length of vertex. Outer claval vein slightly incurved but not touching inner claval vein.

Male genitalia: Pygofer caudally rounded, without process, setae scattered. Style with parallel sided middle portion, apophysis with a series of ridges on ventral margin. Connective with stem 0.5 as long as arm, anteriorly bilobed. Aedeagus elongate, slender, with well developed, unpigmented dorsal apodeme 0.5 as long as shaft, distally bilobed; shaft caudo-dorsally curved, compressed, apex bifid, a pair of slender, slightly asymmetrical, short, ventrally directed processes at apical 0.25. Gonopore subapical.

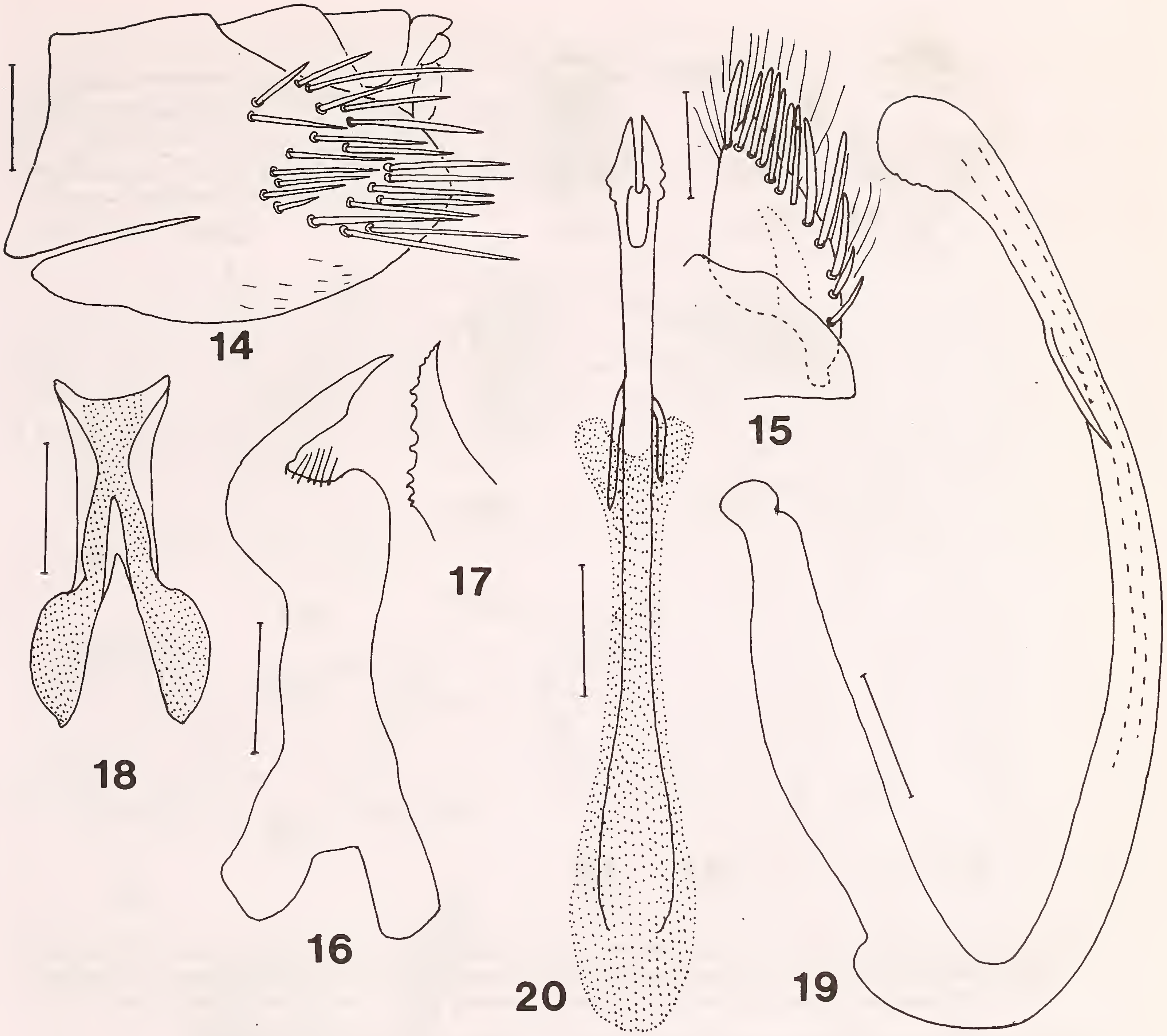
Female genitalia: Seventh sternum three times as long as sixth; hind margin broadly produced medially.

Measurements: Male 5.30 to 5.40 mm long, 1.30 mm wide across eyes., Female 6.00 mm long, 1.50 wide across eyes.

Material examined: Holotype male, INDIA: Tamil Nadu: Shembhaganur, 1300 m, 18.viii.1979, I. Dworakowska Coll. (UAS). Paratypes: 1 male, 1 female, mounted on the same card, *S. INDIA:* Madras, Kodaikanal, T.V.Campbell (NHM).

Remarks: The specimens from the type series of *Scaphoideus redundans* Distant collected from Kodaikanal belong to *S. arcuatus* whereas those from Lovedale to *S. redundans*. Externally both species resemble very closely, however, *S. arcuatus* has a much elongate, slender aedeagal shaft with very short subapical processes while *S. redundans* has shorter, stouter aedeagal shaft with longer, stouter, apical aedeagal shaft appendages. *S. arcuatus* appears to be related to *S. indicus* as they share the character of pygofer and elongate aedeagal shafts. The aedeagal shaft of *indicus* lacks the process whereas *arcuatus* has slender, short, asymmetrical pair of processes.

Scaphotettix freytagi sp. nov.
(Figs. 21 - 32)

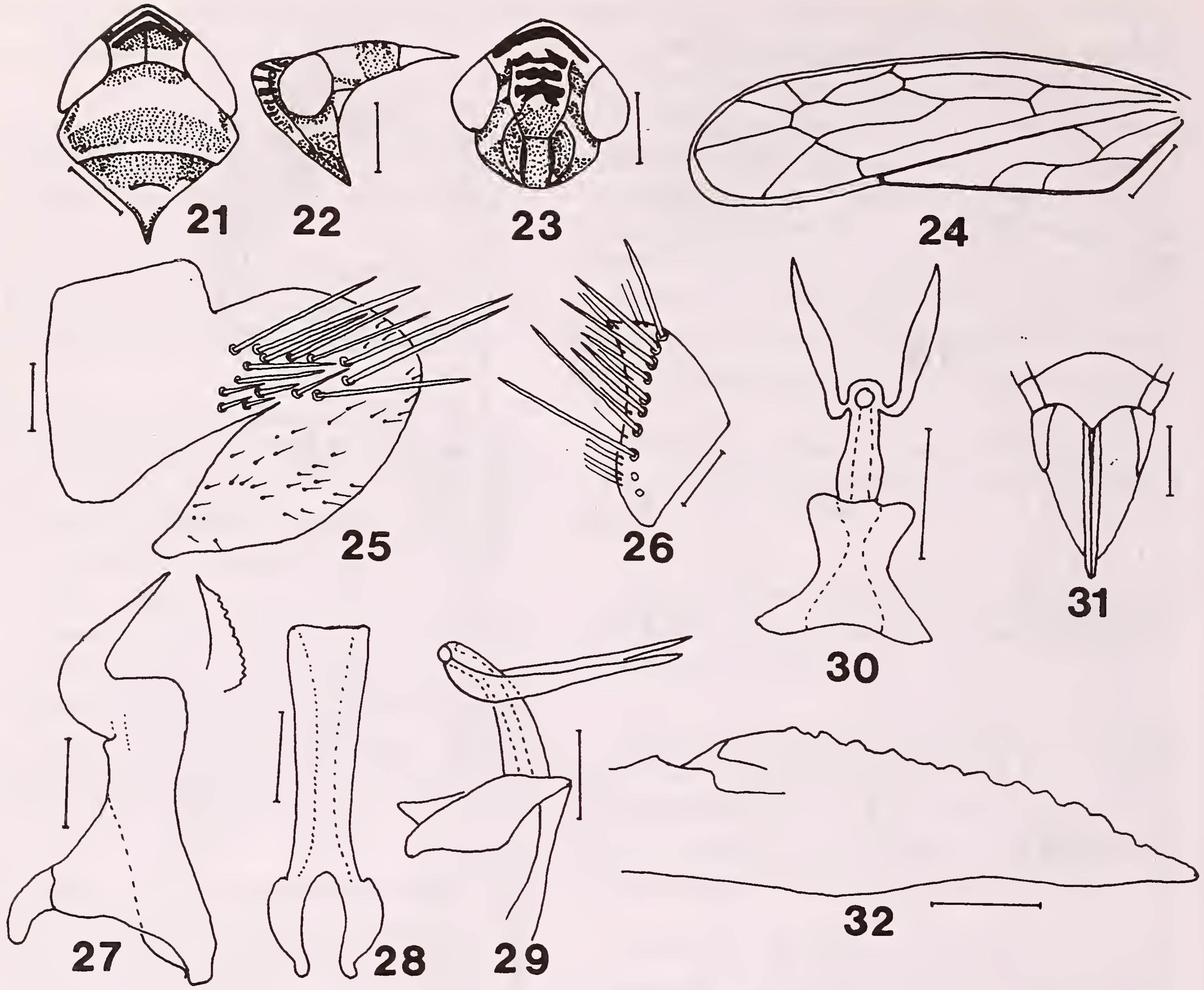


Figs. 14 - 20. *Scaphotettix arcuatus* sp. nov. : 14. Male pygofer; 15. Valve and subgenital plate; 16. Style; 17. Apophysis of style; 18. Connective; 19. Aedeagus, lateral view; 20. Aedeagus, dorsal view. (Scale indicates 0.1 mm.)

Colour as in *S. indicus* but reddish markings on head and thorax are very bright especially in female. In male,l, face with a few medially interrupted bands at basal half of frons, antennal pits, a spot below each eye, lateral margin, discal spot to lorum dark brown to piceous. Claval veins, and some corial veins bright red. In female, face darker especially in apical half including parts of genae, entire lorum, clypellus, apical 0.33 of frons dark brown, a transverse fascia across middle of frontoclypeus and middle of genae ochraceous.

Head obtusely rounded; interocular distance on vertex 1.33 times as wide as median length. Claval veins fused in middle.

Male genitalia: Pygofer with rounded caudal margin, with scattered setae, without process. Style



Figs. 21-32. *Scaphotettix freytagi* sp.nov. : 21. Head and thorax; 22. Same profile ; 23. Face; 24. Fore wing ; 25. Male pygofer ; 26. Subgenital plate ; 27. Slyle ; 28. Connective ; 29.Aedeagus ; lateral view ; 30.Same caudodorsal view ; 31. Ovipositor ; 32. Female second pair of valvula. (Scale indicates 0.5 mm in Figs. 21-24 and 31, and 0.1 mm in others.)

stout, apophysis curved with serrated ventral margin. Stem of connective twice as long as arm. Aedeagus rather L-shaped, dorsal apodeme well developed, bifid distally; shaft straight, directed caudodorsally with a pair of apical, long, strongly recurved appendages directed ventrally and caudally. Gonopore apical.

Female genitalia: Seventh sternum three times as long as sixth; hind margin conically produced in middle. Second pair of valvulae with 15 teeth, margin of teeth finely serrate.

Measurements: Male 4.40 to 4.70 mm long, 1.17 to 1.22 mm wide across eyes. Female 5.00 to 5.20 mm long and 1.35 to 1.40 mm wide across eyes.

Material examined: Holotype male, INDIA: Kerala: Thekkadi, (840m), 27.iii.1977, C.A. Viraktamath (UAS). Paratypes: 4 males, 5 females, data as for holotype, 2 males, 4 females, data as for holotype but collected by S. Viraktamath; 11 males, 7 females, data as for holotype but collected on

26.iii.1977 by C.A. Viraktamath (3 males, 2 females), S. Viraktamath (3 males, 1 female), and B. Mallik (5 males, 4 females); Karnataka: 1male, Mudigere, 7.iv.1975, C.A. Viraktamath; 3 females, Jog Falls, 8.v.1976, B. Mallik; 1 male, 17.xi.1976, B. Mallik; 1 male, 10.xi.1976, C.A. Viraktamath (IARI, NHM, NMNH, UAS).

Remarks: S. freytagi is distinctive among the species of *Scaphotettix* in that the claval veins are fused in the middle. It externally resembles *S. quadrifidus* from which it differs in having only one pair of aedeagal shaft appendages, much brighter coloration and darker face.

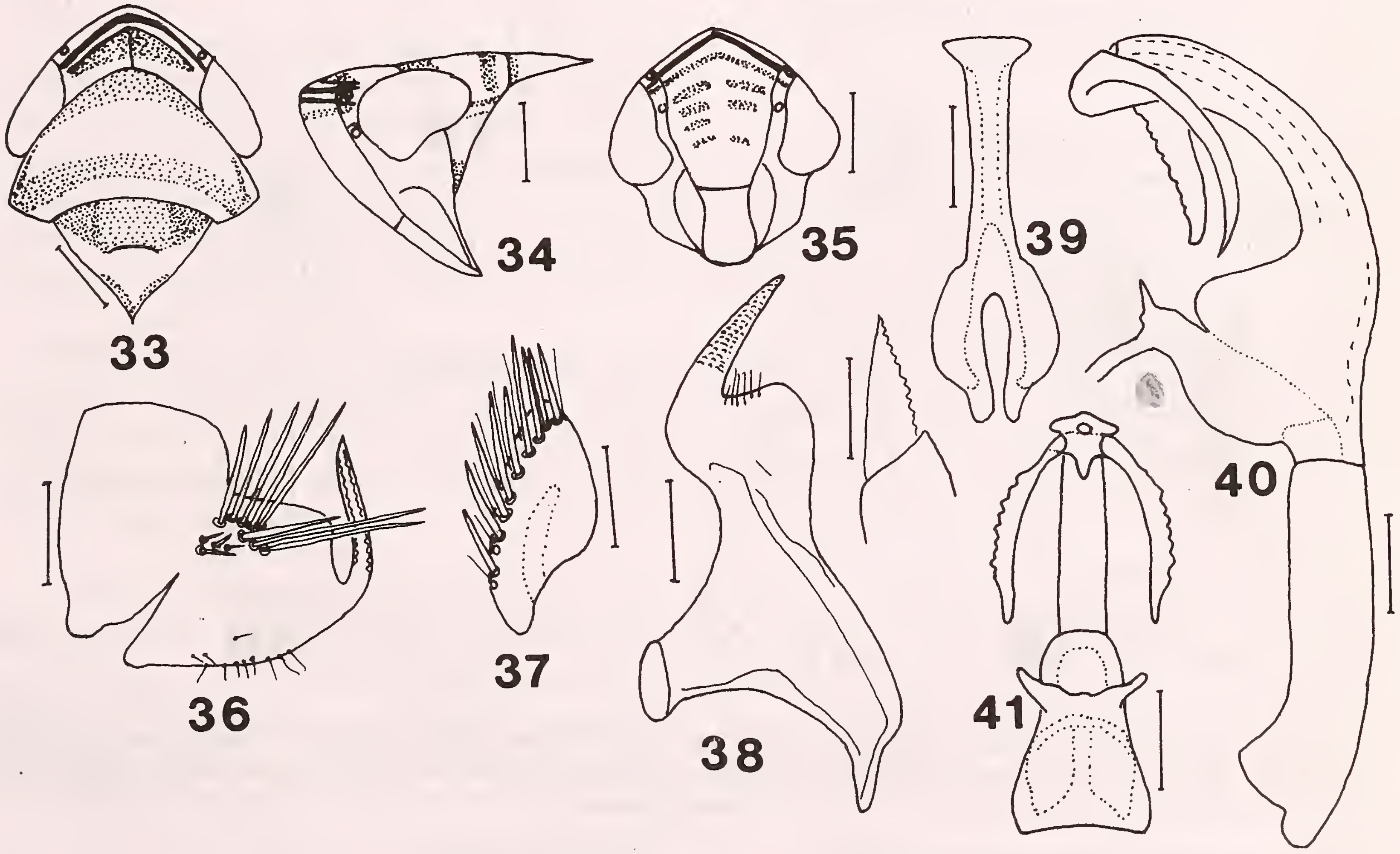
The species is named in honour of Dr Paul H. Freytag, Professor of Entomology, University of Kentucky, Lexington, U.S.A.

Scaphotettix redundans (Distant) comb. nov.
(Figs. 33 - 41)

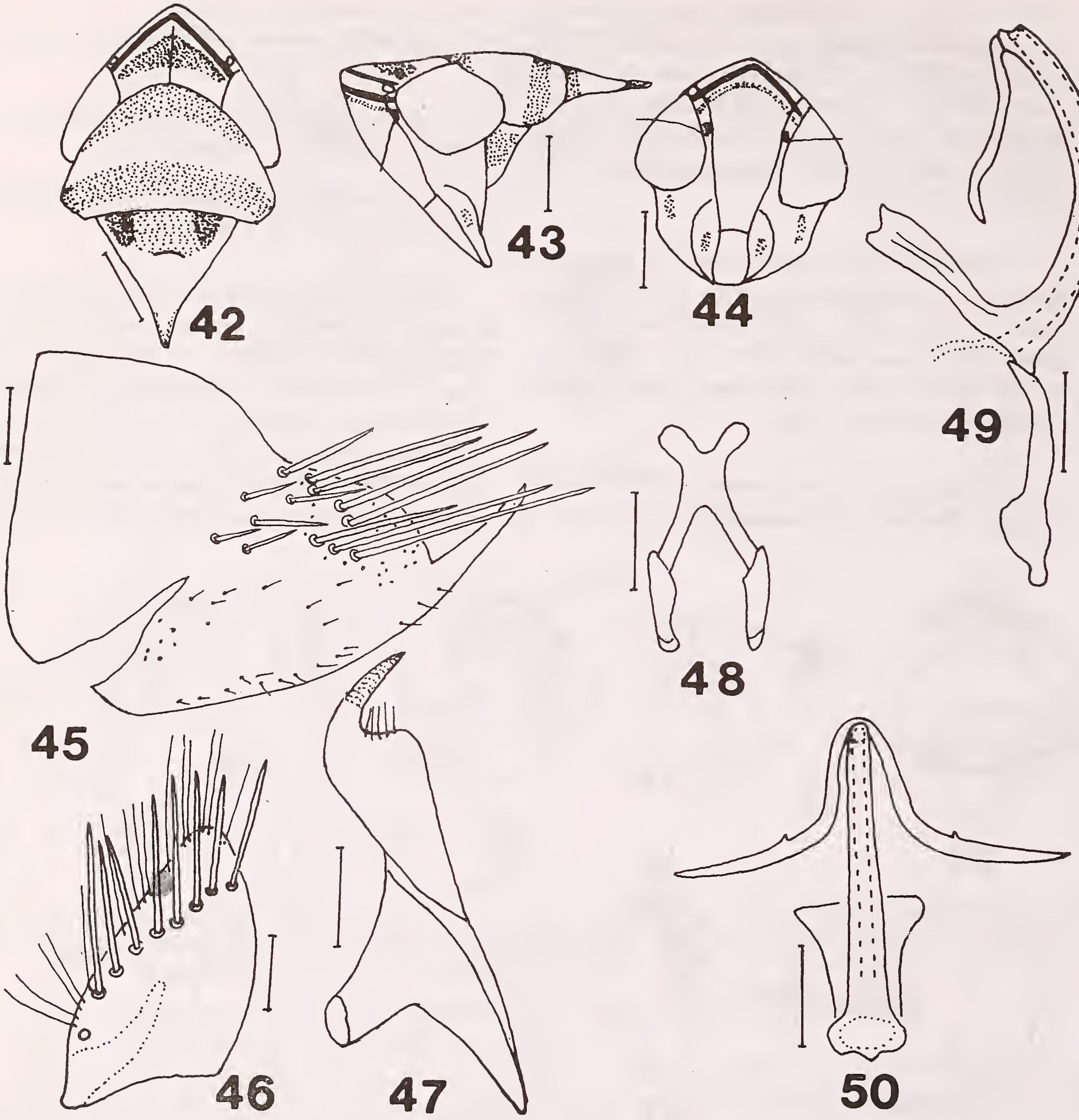
Scaphoideus redundans Distant, 1918:64. Lectotype , here designated Nilgiris (NHM, examined).

Coloration as described by Distant (1918) and very similar to that of *S. arcuatus*.

Male genitalia: Pygofer with a ventral dorsally produced process, exceeding dorsal margin of pygofer. Style with laterally curved apophysis having serrated ventral surface. Connective with stem twice as long as arm. Aedeagus with well developed but short dorsal apodeme, shaft curved caudo-dorsally in lateral aspect slightly broader at apex than at base, with a pair of apical, latero-anteriorly directed blade-



Figs. 33-41. *Scaphotettix redundans* (Distant): 33. Head and thorax; 34. Same, profile; 35. Face; 36 Male pygofer; 37. Subgenital plate; 38. Style and apophysis of style; 39. Connective; 40. Connective and aedeagus, lateral view; 41. Aedeagus, dorsal view. (Scale Indicates 0.5 mm in Figs. 33-35 and 0.1mm in others.)



Figs. 42 - 50. *Scaphotettix agumbensis* sp.nov. : 42. Head and thorax; 43. Same, profile; 44. Face; 45. Male pygofer; 46. Subgenital plate; 47. Style; 48. Connective; 49. Connective and aedeagus; 50. Aedeagus, caudal view. (Scale indicates 0.5mm in Figs. 42-44 and 0.1mm in others.)

like appendages with crenulate margin.

Measurements: Male 5.8 mm long, 1.45 mm wide across eyes.

Material examined: Lectotype , “Type, H.T.

(on red bordered disc)" "Nilgiri Hills, Lovedale, T.V. Campbell" "S. India, E.A. Butler, 1915 -60" here designated (NHM). Paralectotype: 1 female data as for lectotype, mounted along with lectotype on the same card (NHM). *Other material:* INDIA: Tamil Nadu: 1 male, Naduvattam, 6.vi.1977, C.A. Viraktamath (UAS).

Remarks: This species can be easily distinguished by the aedeagal shaft appendages with crenulate margin. It is distantly related to *S. agumbensis* and *S. malnadicus* with which it shares the similarly placed aedeagal shaft process and pygofer process but differs in having the stem of connective twice as long as arms.

Scaphotettix agumbensis sp. nov.

(Figs. 42 - 50)

Ochraceous. Anterior margin of red band on vertex without a dark brown line. Fore wing pale brownish hyaline with prominent dark brown markings surrounding hyaline spots distributed on clavus and corium; apex of clavus, a spot at apex of inner claval vein, submarginal band on apex of fore wing dark brown. Leg coloration as in *S. indicus.*

Head bluntly conical, slightly narrower than prothorax. Vertex slightly shorter than interocular width. Pronotum 1.8 times as wide as long. Claval veins approximated in middle, outer anteapical cell 0.75 as long as median cell.

Male genitalia: Ventrocaudal angle of pygofer lobe produced into a spine-like process directed caudodorsally. Style slender, elongate, apophysis short, slender, strongly curved laterally, its surface pustulated. Stem of connective 0.5 as long as arms, strongly bifid anteriorly. Aedeagus slender, dorsal apodeme thin, plate-lilke, 0.5 as long as a shaft; shaft gradually curved caudodorsally, of uniform width, with a pair of apical appendages, each appendage directed anteriorly at basal 0.33 then abruptly directed laterally, with a tooth at midlength. Gonopore apical.

Measurements : Male 5.00 mm long, head 1.27 mm wide across eyes.

Material examined: Holotype male, INDIA: Karnataka: Agumbe, 23.xi.1982, H.V.A. Murthy Coll. (UAS). Paratype 1 male, INDIA: Karnataka: Bhagamandala, 1300 m, 25.i.1980, S.Viraktamath Coll. (NHM).

Remarks : S. agumbensis shares the character of anteriorly bifid stem of connective and pygofer process with that of *S. malnadicus.* It has however, more slender, elongate style with shorter apophysis, elongate, slender differently shaped appendages of aedeagal shaft. It is also related to *S. quadrifidus* sp. nov. as discussed under that species.

Scaphotettix malnadicus sp. nov.

(Figs.51 - 59)

Coloration of head and thorax as in generic diagnosis. Scutellum with basal triangles brown, red band between them interrupted by ochraceous line, apical half yellowish white with piceous lateral margins. Forewing as in *S. agumbensis.*

Head bluntly conical, slightly narrower than pronotum. Vertex 0.78 as long as interocular distance. Pronotum 1.8 times as wide as long. Claval veins approximated in the middle. Outer anteapical cell 0.75 as long as median anteapical cell.

Male genitalia : Caudoventral margin of pygofer with a caudally directed process, caudodorsal margin membranous. Style with slender, strongly, laterally directed apophysis with serrated ventral margin connective rather x-shaped, anterior arm very short, caudal arms slender,elongate. Aedeagus with poorly developed dorsal apodeme, shaft slightly caudodosorsally curved , broader at base than at apex with a pair of apical anteroventrally curved appendages. Gonopore subapical.

Measurements: Male 4.90 mm long, 1.30 mm wide across eyes.

Material examined: Holotype male, INDIA: Karnataka: 35 Km W of Jog Falls, 534 m, 18.xi.1976, C.A Viraktamath (UAS).

Remarks : S. malnadicus is closely related to *S.agumbensis* from which it can be distinguished by the stouter aedeagal shaft, differently curved shaft appendages and the shape of pygofer.

Scaphotettix quadrifidus sp. nov.

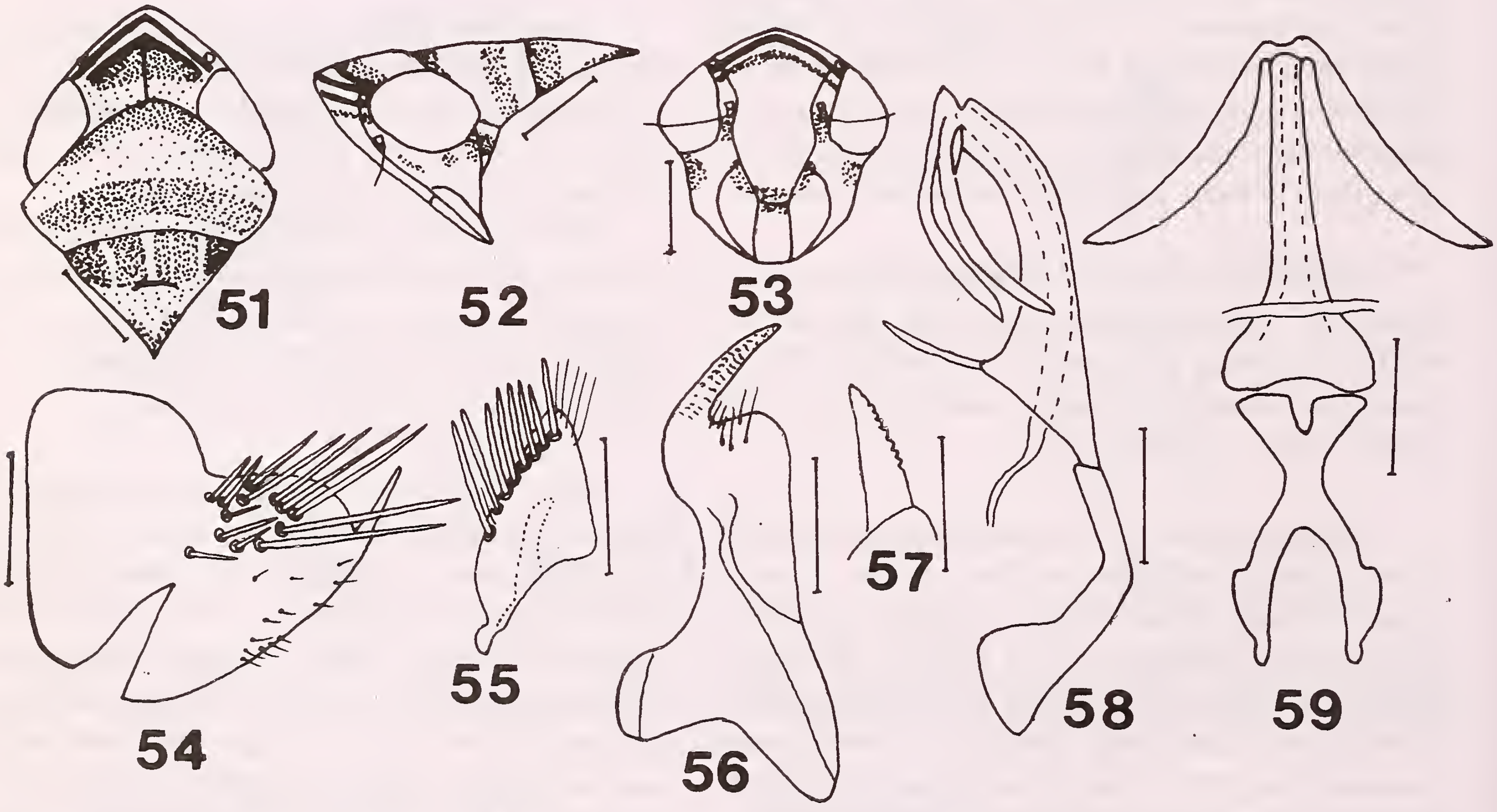
(Figs.60 - 72)

Coloration as described in generic diagnosis. Dorsal half of frons in male brownish ochraceous, in female with a series of medially interrupted transverse fasciae, lateral frontal sulcus, antennal half of scutellum beyond red band ochraceous, apical half yellow. Fore wing coloration as in *S. agumbensis* with darker venation, claval veins red, more so in female. Leg coloration as in *S. indicus.*

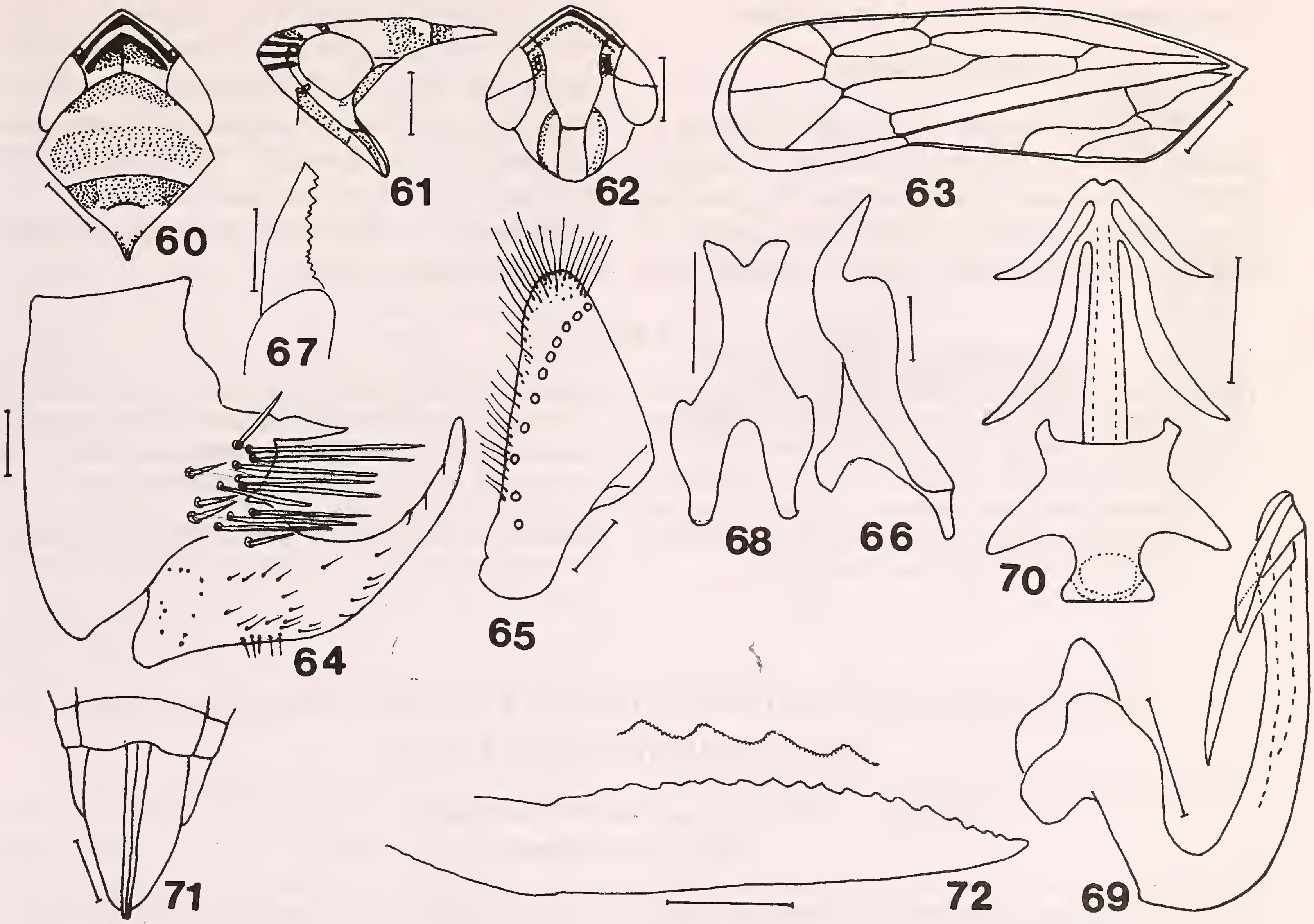
Head 0.75 as long as interocular distance. Pronotum 1.7 times as wide as long. Claval veins connected by a cross vein.

Male genitalia: Pygofer lobe caudally attenuated gradually and produced into a dorsally curved process caudodorsal margin with a short caudally directed process. Style with short, finger-like apophysis directed laterally, with transversely rugose ventral area. Connective with stem 0.5 as long as arm. Aedeagus rather J-shaped with well developed dorsal apodeme, shaft of uniform width with a pair of apical and another pair of subapical appendages. Gonopore apical.

Female genitalia : Seventh sternum as long as sixth, its caudal margin medially, slightly, concavely excavated. Second pair of valvula with 17 teeth,



Figs. 51-59. *Scaphotettix malnadicus* sp. nov. : 51. Head and thorax ; 52. Same, profile ; 53. Face; 54. Male pygofer; 55. Subgenital plate ; 56. Style ; 57. Apophysis of style ; 58. Connective and aedeagus, lateral view; 59. Same, dorsal view. (Scale indicates 0.5 mm in Figs. 51-53 and 0.1 mm in others.)



Figs. 60 - 72. *Scaphotettix quadrifidus* sp. nov. : 60. Head and thorax; 61. Same, profile; 62. Face; 63. Fore wing; 64. Male pygofer; 65. Subgenital plate; 66. Style; 67. Apophysis of style; 68. Connective; 69. Aedeagus, lateral view; 70.Same, dorsal view; 71. Ovipositor; 72. Female second valvula. (Scale indicates 0.5mm in Figs. 60-63 and 71, and 0.1mm in others.)

entire dorsal margin including teeth finely crenulate.

Measurements: Male 5.3 to 5.5 mm long 1.37 to 1.42 mm wide across eyes. Female 5.8 to 6.0 mm long, 1.47 to 1.62 mm wide across eyes.

Material examined: Holotype male, INDIA: Kerala:Thekkadi (840 m). 26.iii.1977, C.A. Viraktamath (UAS). Paratypes: 3 males, 4 females, data as in holotype ; 1 male, data as in holotype but collected on 27. iii. 1977., 4 males, 3 females, data as in holotype but collected by S. Viraktamath (2 males, 3 females) and Mallik (2 males) (IARI, NHM, NMNH, UAS).

Remarks : *S. quadrifidus* can be easily recognised by its aedeagal shaft appendages which are four in number. The species *S. quadrifidus, S. agumbensis* and *S. malnadicus* form a more or less uniform group as they share the characters of pygofer and connective. They are related to *s. redundans* in this character but the latter has a much longer stem of the connective. Externally *S. quadrifidus* resembles *S. freytagi* in having bright red coloured bands and claval veins. However, the claval veins are not fused in *S. quadrifidus.*

ACKNOWLEDGEMENTS

We thank Dr Paul H. Freytag, Professor of Entomology, University of Kentucky, Lexington, U.S.A. for the generic placement of *Scaphoideus rendundans* and *S. indicus* and for the illustrations of type series of *Scaphoideus* species described from India received through Dr Baldev Sharma, University of Jammu, Jammu. The first author thanks Dr W.J. Knight and Mr. M.D. Webb for allowing him to study the type series of species of *Scaphoideus* described by Distant and Mr. Webb and Dr M.R. Wilson, CAB International Institution of Entomology, London for the hospitality provided during his stay in London.

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ON TWO NEW SPECIES OF *CHELONUS* PANZER (HYMENOPTERA: BRACONIDAE) FROM INDIA[1]

S.M. KURHADE[2] AND P.K. NIKAM[3]

(With six text-figures)

Chelonus (Microchelonus) pikeni sp. nov. and *Chelonus (Microchelonus) raoi* sp. nov. are described and illustrated. The Key to the Indian species of *Chelonus (Microchelonus)* by Rao and Chalikwar (1971) is amended.

INTRODUCTION

Chelonus is a moderate sized genus belonging to the subfamily Cheloninae of the family Braconidae. *Chelonus* is divided into two subgenera, namely *Chelonus* Panzer and *Microchelonus* Szepligeti. The earlier works on the Indian species of *Chelonus* are by Subba Rao (1955), Gupta (1955) and Rao and Chalikwar (1971). In the present work two new taxa belonging to the genus *Chelonus,* namely *Chelonus (Microchelonus) pikeni* and *Chelonus (Microchelonus) raoi* are described and the key to the Indian species of *Chelonus (Microchelonus)* by Rao and Chalikwar (1971) is amended to include the new taxa.

Types and other material of these species are in the collection of the junior author for the time being and will be deposited in the National Collection of the Zoological Survey of India, Calcutta, India.

Chelonus (Microchelonus) pikeni sp. nov.

(Figs. 1-3)

MALE : 3.1 mm (Fig. 1). Head (Fig. 2) transverse, 2.5 x as wide as long; vertex rugose, pubescent;

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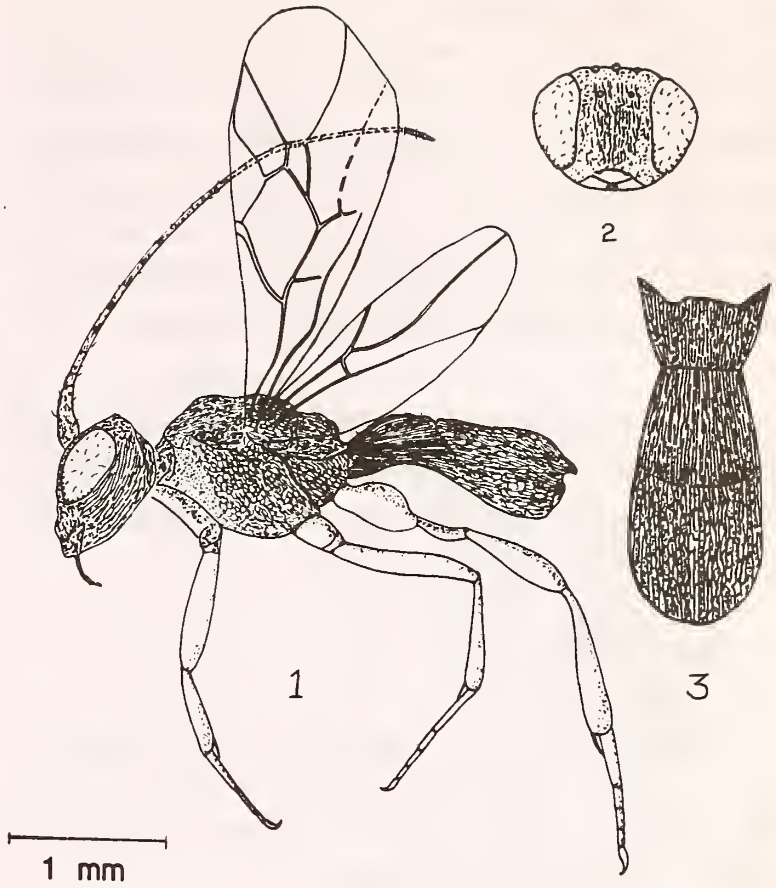
ocelli in triangle, with broad base, base of the triangle twice the height: frons rugose, without median longitudinal carina, closely punctate, pubescent; face 0.5 times as long as wide, rugose, sparsely punctate, pubescent, with median longitudinal carina; clypeus 0.45 times as long as wide, slightly convex, shiny, closely punctate, pubescent; malar space rugosely, sparsely punctate, pubescent, 1.25 x as long as the basal width of mandible; mandible 3 x as long as the basal width, bidentate, punctate, finely pubescent; antenna 2 + 22 segmented; scape 2.45 x as long as broad, finely, shallowly punctate, finely pubescent; pedicel 0.65 times as long as broad, finely, shallowly punctate, finely pubescent; penultimate segment 1.5 x as long as wide; terminal segment 2 x as long as wide; maxillary palps long, 5 segmented; occipital carina present; temple broad, strigose, moderately punctate, finely pubescent, 0.4 times as wide as height of the eye; eye 2.5 x as long as wide, with fine pubescence.



Figs. 1 - 3. *Chelonus (Microchelonus) pikeni* sp. nov. (male). 1. Adult, lateral view ; 2. Head, frontal view; 3. Propodeum with abdomen.

Thorax: Pronotum closely, deeply punctate, pubescent; mesoscutum rugosely, closely punctate; notauli distinct; disc of scutellum slightly convex, irregularly, reticulately rugose, moderately, shallowly punctate, with lateral depressions; scutellar furrow with nine distinct carinae; mesopleurum irregularly, reticulately rugose, pubescent, with prominent mesopleural suture; metapleurum irregularly, reticulately rugose, pubescent; propodeum (Fig. 3) irregularly rugoso - reticulate, lateral projections distinct. Hind coxa globular, 1.8 x as long as wide; trochanter 0.4 times as long as femur; femur 1.25 x as long as coxa; tibia 1.4 x as long as femur; tibial spur 0.4 times as long as basitarsus; tarsus five segmented; claw simple. Fore wing : 2.6 x as long as broad; stigma 2.8 x as long as wide; radial cell on wing margin 0.8 times as long as stigma; first abscissa of radius 0.4 times as long as first intercubitus, 0.8 times as long as second abscissa of radius; apical abscissa of radius 5.5 x as long as first abscissa; costa 2.25 x as long as stigma; medius 0.7 times as long as costa, 1.5 x as long as basal; nervulus inclivous, distad, 0.7 times as long as width of stigma; subdiscoideus sclerotized, 1.75 x as long as stigma; second intercubitus unpigmented, 0.5 times as long as first intercubitus; cubitus 2.25 x as long as stigma; Hind wing: 3.4 x as long as broad; subcostella 0.9 times as long as radiella; nervellus reclivous, basad, 1.4 x as long as basella.

Abdomen: 1.9 x as long as wide, broadly sessile, apex rounded, slightly shorter than head and thorax combined, coarsely longitudinally striate at basal half, pubescent; apical half reticulately rugose, pubescent; foramen in the apex of the carapace narrow, oval, well margined, 3.55 x as wide as its height.

Genitalia: Gonoforceps, volsellae and aedeagus situated on sclerotic ring; volsella and aedeagus enclosed by gonoforceps, later elongated;

gonosquammae elongate, curved; gonostipes flat; gonocardo slightly rounded; gonolacinae weakly taper apically, teeth absent; apodeme short; distivolsella short, curved, apically moderately pointed; aedeagus without teeth ; parameres elongate, apically pointed; subgenital plate transverse, wide than long, sparsely pubescent, anticosta moderately sclerotized; spiculum short, triangular.

Coloration: Black. Scape, fore leg, mid leg, femur and tibia of hind leg basally light brown; stigma, veins reddish-brown; 0.45 basal part of carapace white.

FEMALE : Unknown.

Holotype: MALE ; Ahmednagar, : Maharashtra INDIA, 13. viii. 1988, Malaise trap, S.M. Kurhade Coll.; Antenna, wings, legs and genitalia mounted on slides and labelled as above.

Paratype: 6 males, data same as holotype.

Comments: According to the key to the Indian species of the subgenus *Microchelonus* by Rao and Chalikwar (1971), the new species, *Chelonus (Microchelonus) pikeni* runs close to *Chelonus (Microchelonus) notaulii* Rao and Chalikwar (1971) in the characters of : (i) face with a median longitudinal carina and (ii) antenna 24 segmented. However the new taxa differs from *notaulii* in the following characters: (i) head 2.5 x as wide as long, (ii) frons without median longitudinal carina, (iii) malar space 1.25 x the basal width of mandible, (iv) face 0.5 times as high as wide, (v) fore wing 2.6 x as long as broad and (vi) stigma 2.8 x as long as wide. The new species superficially resembles *with C. (Microchelonus) nigripes* Rao and Chalikwar (1971), but differs in the following characters: (i) head 2.5 x as wide as long, (ii) malar space 1.25 x as the basal width of mandible, (iii) fore wing 2.6 x as long as broad, (iv) stigma 2.8 x as long as wide and (v) antenna 24 segmented.

Chelonus (Microchelonus) raoi sp. nov.
(Figs. 4-6)

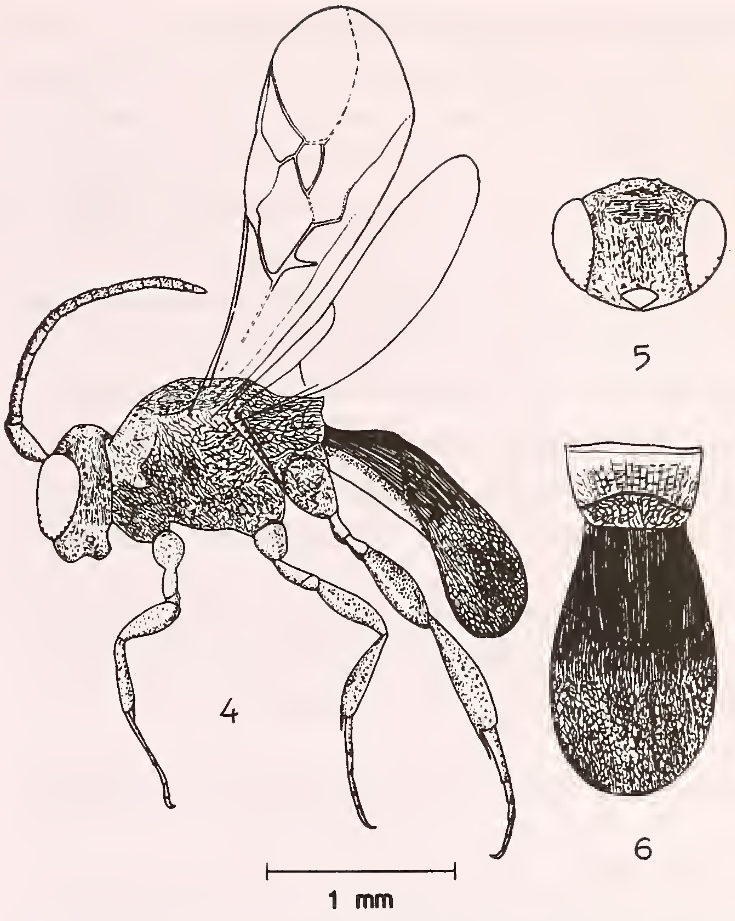
FEMALE: 2.5 - 2.8 mm. (Fig. 4). Head (Fig. 5) 2.45 x as wide as long; vertex rugose, finely punctate, sparsely pubescent; interocellar space 0.7 times the ocellocular space; frons without median longitudinal carina, transversely striate medially, rugose on lateral sides ; face 0.5 times as long as wide, rugose, punctate, pubescent; clypeus 0.8 times as long as wide, closely, deeply punctate, pubescent; clypeal fovea distinct; mandible bidentate, 2.5 x as long as its basal width; malar space 2.35 x as long as basal width of mandible, rugoso-punctate, pubescent; temple 0.5 times as broad as height of the eye, rugose, striate, punctate, pubescent; eye 2.5 x as long as wide, sparsely pubescent; occiput smooth, margined; antenna filiform, extending back nearly to the base of carapace, 2 + 14 segmented; scape 2.25 x as long as wide; pedicel 1.5 x as long as wide; post pedicel 2.65 x as long as wide; penultimate segment as long wide; terminal segment 2 x as long as wide; antenna pubescent throughout the length.

Thorax : 1.25 x as long as wide; collar rugose, sparsely punctate; pronotum rugoso-reticulate, sparsely punctate, pubescent; mesoscutum reticulate, rugose, sparsely punctate, pubescent; notauli absent; disc of scutellum moderately convex, smooth at the centre, crenulated on basal and lateral sides; furrow crenulated at the base of the propodeum; propodeum (Fig. 6) reticulately rugose, with three median longitudinal carinae; apical transverse carina raised; outer pair of propodeal apophysis distinct, acute; inner pair not distinct; propodeal spiracle minute, circular; mesopleurum reticulately rugose, foveolate, pubescent; mesopleural furrow crenulately rugose, foveolate, pubescent; metapleurum reticulately rugose, foveolate, pubescent. *Fore wing*: 2.6 x as long as broad; stigma 2.6 x as long as wide; radial cell on wing margin 1.3 x as long as stigma; metacarpus as long as stigma; costa 1.35 x as long as medius; 1st abscissa of radius 0.65 times the width of stigma; 2nd abscissa of radius as long as 1st abscissa; 3rd abscissa of radius as long as length of stigma, 6 x as long as 2nd abscissa; discoidal cell confluent with 1st cubital cell; second inter cubitus 0.5 times the first intercubitus, unpigmented; basal 0.85 times the length of stigma, 0.5 times the length of medius; discoideus 0.65 times the length of medius; nervulus inclivous, distad, 0.85 times the width of stigma; recurrent unpigmented, as long as nervulus; submedius 1.35 x as long as medius; brachius 1.4 x as long as width of stigma; subdicoideus 1.10 x as long as medius. *Hind wing*: 3.85 x as long as broad; sub costella 1.65 x as long as mediella; basella 0.1 times as long as mediella. Hind coxa globular, shallowly punctate, pubescent, 1.5 x as long as wide; 1st trochanter 1.75 x as long as wide; 2nd trochanter 1.65 x as long as wide; femur closely, deeply punctate, pubescent, 3.3 x as long as wide; tibia 1.25 x as long as femur, punctate, pubescent, 4.15 x as long as wide apically; longer tibial spur 3 x as long as basitarsus; basitarsus 0.4 times the length of tibia; tarsus 5 segmented; claw simple, bifid.

Abdomen: Broadly sessile, 1.7 x as long as wide, apex rounded, longitudinally striate at basal half becoming reticulately rugose on apical half, finely pubescent, with two strong posteriorly converging keels arising from the base; foramen in the apex of carapace wanting.

MALE: Unknown.

HOLOTYPE: FEMALE; Aurangabad, Maharashtra: INDIA: 15. ix. 1990, reared on *Heliothis armigera* larva by S.N. Ambekar; Antenna, wings and legs mounted on slides and labelled as above.



Figs.4 - 6. *Chelonus (Microchelonus) raoi sp. nov. (Female).* 4. Adult, lateral view ; 5. Head, frontal view ; 6. Propodeum with abdomen.

Comments: According to the key to the Indian species of the subgenus *Microchelonus* Rao and Chalikwar (1971), *Chelonus (Microchelonus) raoi* sp. nov. runs close to *C.(M.) notaulii* Rao and Chalikwar (1971) in the characters of : (i) occiput smooth, margined, (ii) 16 segmented antennae, (iii) propodeum reticulately rugose, (iv) outer pair of propodeal projections distinct, (v) propodeal spiracle minute, small, circular, (vi) mesopleurum reticulately rugose, (vii) coxae globose, (viii) carapace broadly sessile, apex rounded, (ix) carapace longitudinally striate at basal half, (x) foramen in the apex of carapace absent. However, the new taxa is distinguished from *Chelonus (Microchelonus) notaulii* by the following characters: (i) vertex rugose, and finely punctate, (ii) frons without median longitudinal carina, (iii) frons transversely striate, (iv) clypeus closely, deeply punctate, (v) malar space 2.35 x as the basal width of mandible, (vi) scape 2.25 x as long as its own width, (vii) mesoscutum reticulately rugose, (viii) notauli absent, (ix) fore wing 2.6 x as long as broad, (x) stigma 2.6 x as long as wide, (xi) first abscissa of radius 0.65 times the breadth of stigma and (xii) basitarsus 0.4 times as long as tibia.

The new taxa superficially resembles *C. (M.) nigripes* Rao and Chalikwar (1971) but differs from it in the following characters: (i) vertex rugose, finely punctate, (ii) inter oceilar space 0.7 times the ocellocularspace, (iii) frons without median longitudinal carina, (iv) clypeus closely, deeply punctate, (v) malar space 2.35 x as the basal width of mandible, (vi) scape 2.25 x as long as wide, (vii) temple rugose, striate, (viii) mesoscutum reticulate, rugose, (ix) disc of scutellum smooth at the centre, (x) mesopleurum reticulately rugose, (xi) tibia 1.25 x as long as femur and (xii) fore wing, 2.6 x as long broad.

The name *raoi* is in honour of Dr. S.N. Rao, Ex-Professor of Entomology, Department of Zoology, Marathwada University, Aurangabad.

KEY TO THE INDIAN SPECIES OF *Chelonus (Microchelonus)* PANZER BY RAO AND CHALIKWAR (1971)

1. Front and middle coxae yellow; malar space 1.3 x the basal width of mandible. Basal 0.45 part of carapace white; ovipositor 1.25 x as long as the hind basitarus; male with antenna 24-25 segmented, foramen in the apex of carapace 3.5 x as wide as high.. ....*notaulii* Rao and Chalikwar, 1971.

- Front and middle coxae not yellow; malar space more or equal to the basal width of mandible 2

2. Fore and mid legs light brown; malar space 1.25 x as the basal width of mandible. Frons without median longitudinal carina; male with antenna 24 segmented; foramen in the apex of carapace 3.55 x as wide as high ....*pikeni* sp.nov.

- Fore and mid legs reddish-brown or black; malar space equal or more than twice the basal width of mandible......3

3. Legs dark reddish-brown; malar space 2.35 x the basal width of mandible. Notauli absent. Antenna 16 segmented. Basal 0.45 part of carapace yellowish - white...*raoi* sp. nov.

- Front and middle coxae reddish -brown or black; malar space equal to the basal width of mandible 4

4. Lateral lobes at base of scutellum present; stigma 2.6 x as long as wide; radial cell on wing margin 0.75 times as long as stigma and 0.8 times as long as third abscissa of radius; basal 0.4 part of carapace yellow; male with antenna 25 segmented, extending to the middle of carapace, foramen in the apex of carapace narrow, 4.5 x as wide as high...........................*nigripes* Rao and Chalikwar, 1971.

- Lateral lobes at the base of scutellum absent; stigma 3.0 x as long as wide; radial cell on wing margin almost as long as stigma; basal third part of carapace white; male with antenna 24-26 segmented; extending to the apex of carapace, foramen in the apex of carapace 4.0 x as wide as high ....*heliopae* Gupta, 1955

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DESCRIPTION OF ADULT AND NYMPHAL STAGES OF TWO NEW GALL PSYLLIDS (PSYLLIDAE: HOMOPTERA) FROM INDIA[1]

K. Thenmozhi and C. Kandasamy[2]

(*With four text - figures*)

Introduction

During 1984-85 psyllids were collected in the forests of Siruvani and Thimbam and Yelagiri hills. Of these two species were found to be new to Science assignable to the genera *Arytaina* and *Trioza*. The adults as well as the nymphal stages of the two new species are described in detail.

Key to the Species of *Arytaina* Foerster

1. Radius almost as long as cubital petiole .... *A. ramakrishni* Crawford
- Radius longer than cubital petiole 2

2. Genal cone small with apical setae slightly longer than vertex .... *A. spinosa* Mathur
- Genal cone long with apical setae smaller than vertex .... *A.marsupiae* sp. nov.

1. Description of Adults

1. Arytaina marsupiae sp. nov. (Fig. 1)

Colour: General Colour light brown with ovoid black patches in the lateral margins of the prescutum, antenna blackish brown at the tip of the two segments, genitalia dark brown with highly serrated, forewings hyaline and transparent.

Head: Moderately deflexed, sparsely pubescent, vertex broader than long, about twice as broader as long, possessing dark brown band on the middle reaching the margins on either side, anterior ocellus visible from the above, genal cones long, smaller than the length of vertex, straight, widely placed, possessing two long characteristic setae at the tip of the genal conel, eyes small and hemisperical.

Antenna: Small, slender, longer than width of the head, ten - segmented, two basal segments robust, first broader than second, second as long as first, third longest, about twice as long as first, fifth as long as sixth and both of them shorter than fourth, seventh longer than eighth, ninth and tenth segment, terminal segment brown in colour bearing two unequal setae at the tip, sensoria present on segments fourth, sixth,eighth and ninth.

Leg: Robust, sparsely pubescent, femur serrate with minute setae arranged in lines, tibia shorter and slender than femur, femur with a basal spur and with three thick black spines at apex, in addition, a comb of six thin long setae present. apical tarsal segment broader with two claw like spines at its apex.

Wings: *Forewing*: Small, hyaline, transparent, ovoid, about three times as wide as long, round at apex, pterostigma long and narrow, veins thin, basal vein as long as cubitus and shorter than radius, cubital petiole shorter than radius, marginal cell unequal, first marginal cell small and narrower than second.

Hindwing: Small, transparent , membranous and coastal vein with small setae widely placed.

FEMALE: Genitalia smaller than abdomen, broader at the base, narrow and tapering at the apex, dorsal plate longer than ventral, with long and short setae on the surface, ventral plate broad at base narrow and short at apex, ovipositor short, pointed,

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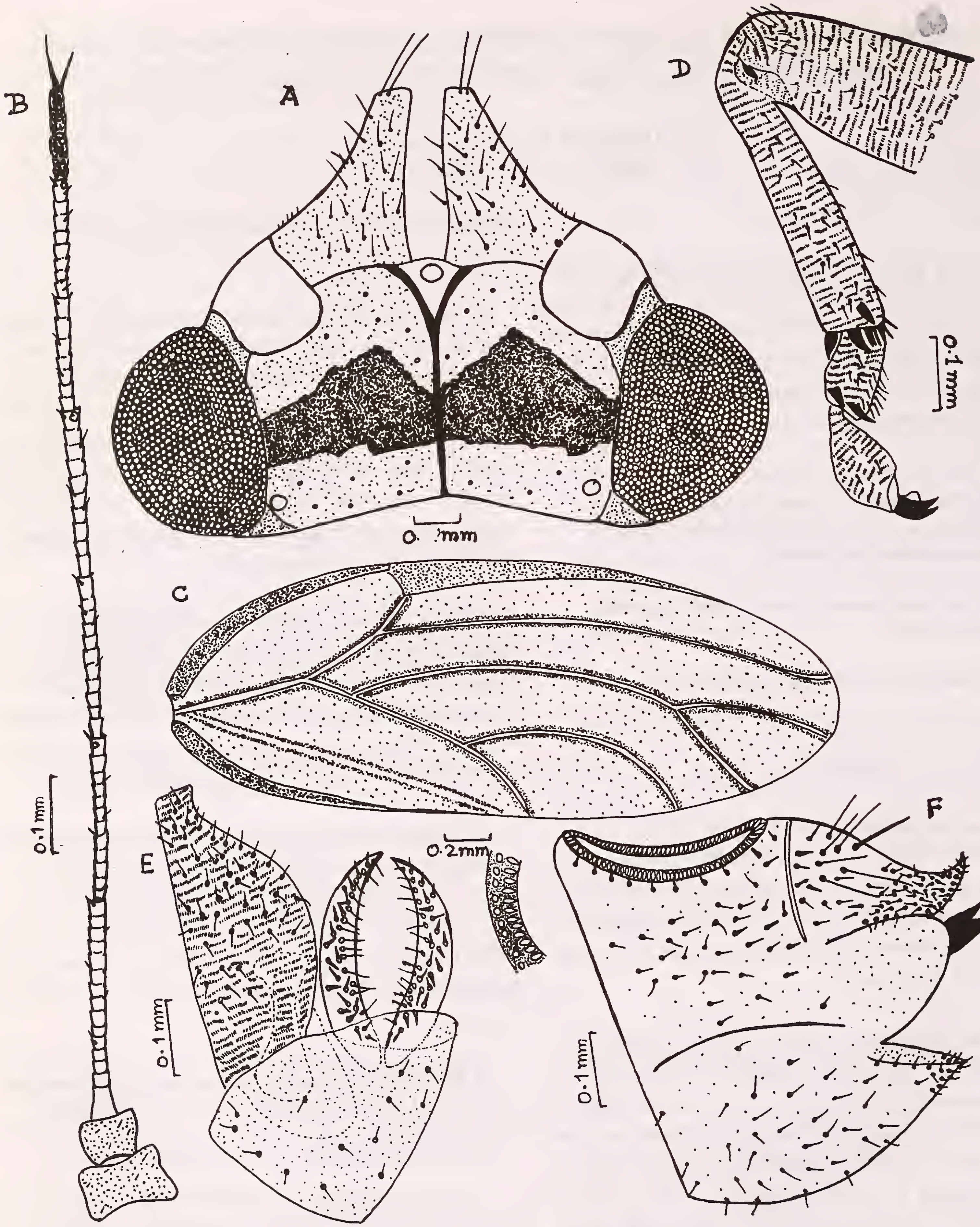
B
A
D
0.1 mm
C
0.1 mm
0.2mm
E
0.1 mm
F
0.1 mm

Fig.1. *Arytaina marsupiae* sp. nov.
A. Head; B. Antenna; C. Fore wing; D. Leg; E. Male genitalia; F. Female genitalia.

anal pore ring ovate, with two rows of pores, inner row longer than the outer.

MALE: Genitalia Smaller than abdomen, anal valve broader and longer than parameres, wide in the middle and narrow at apex, paramere with uniform smooth margin, ending with strong pointed tip, sparsely pubescent, hypandrium brown, triangular in shape, shorter than anal value, aedeagus short ending with spoon like structure.

Measurements (in mm) : FEMALE (MALE)

Width of the head	:	0.850 - 0.860 (0.830)
Width of the vertex	:	0.500 - 0.520 (0.490)
Length of forewing	:	2.601 - 2.662 (2.295)
Length of antenna	:	1.438 - 1.499 (1.420)
Dorsal plate	:	0.460 - 0.500
Ventral Plate	:	0.350 - 0.360
Hypandrium	:	(0.260)
Analvalve	:	(0.340)
Paramere	:	(0.260)

Host plant : *Pterocarpus marsupium* Roxb. (Leguminoceae).

Locality : Siruvani forest, Coimbatore, Tamil Nadu (300 m.).

Types : Holotype female, allotype male mounted on slides, paratypes one male and two females.

Date of collection : August 4, 1984.

Collected by : K. Thenmozhi.

Remarks: *Arytaina marsupiae* sp. nov. is closely related to *A. spinosa* Mathur (Mathur 1975) in the shape of the forewing and the radius being longer than cubital petiol, but is distinct in having long characteristic genal cone with two long apical setae, shape of the anal valve and parameres.

In the Indian subcontinent five species are recorded under the genus *Arytaina*. None of the species are gall makers tough twisting and curling of the young leaf are reported due to feeding by *A. puntipennis* and *A. ramakrishni* (Mani 1973). The present finding of *A. marsupiae* sp.nov. is a first gall forming species under this genus and a new addition to the genus *Arytaina* in India.

2. DESCRIPTION OF THE THIRD TO FIFTH NYMPHAL STAGES (Fig. 2)

Fifth Instar Nymph: Body 2.081 mm long and 1.591 mm wide, head narrower than abdomen; prothorax fused with cephalic region and separated from meso-and metathorax by a membrane; wingpads large and projecting, eyes large and prominent; head plate large extending up to prothoracic region; thoracic plates small and well sclerotized apical region of abdomen fused to form a sclerotized caudal plate which is 0.612 mm long in the dorsal side of the abdomen; small sclerotic plates present in throracic region; antenna 0.796 mm long, robust, third segment longer than fourth, fifth and sixth; terminal segment longest bearing two apical spines at its apex, out of four sensoria two present on segments third and fifth and rest on segment seventh; wingpads well developed, forewing pad 0.623 mm long, twice as wide as long and slightly smaller than length of antenna, margins of forewing and hindwing with 32 and 3 simple setae respectively, hindwing with one lanceolate setae, both the wing pads beset with minute setae and with few simple setae; legs sparsely pubescent, tibia-tarsus articulation well demarcated, tarsus and with two claw like spines, pulvilus small and petiolate; abdomen 1.010 mm long and 1.049 mm wide bearing sclerotized area (anal plate) surrounding the circum anal pore ring, four pairs of well sclerotized plates present surrounding the spiracle near lateral margin of abdomen; margin of abdomen surrounded by simple setae and lanceolate setae in the ratio of 9: 3, circum anal pore ring 0.290 mm wide; more or less bean shaped, placed at the extreme posterior margin of abdomen, consisting of double rings; outer ring with single row of slit like

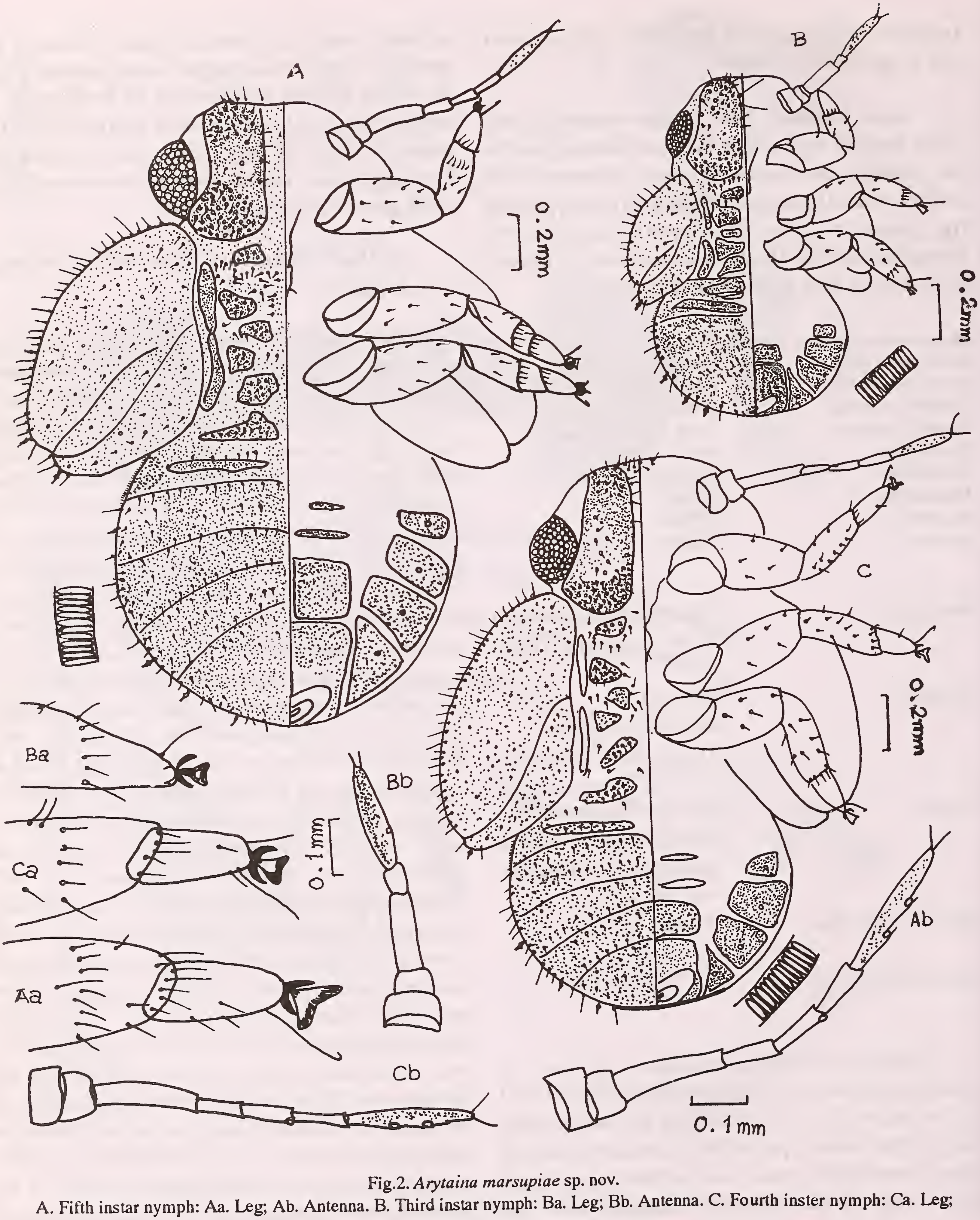
A
B
C
0.2mm
0.2mm
0.2mm
Ba
Ca
Aa
Bb
Cb
Ab
0.1mm
0.1mm

Fig.2. *Arytaina marsupiae* sp. nov.
A. Fifth instar nymph: Aa. Leg; Ab. Antenna. B. Third instar nymph: Ba. Leg; Bb. Antenna. C. Fourth inster nymph: Ca. Leg; Cb. Antenna.

pores and inner ring with minute pores.

Fourth Instar nymph: Body 1.683 mm long and 1.377 mm wide; antenna 0.734 mm long, seven segmented with two sensoria on segments third and fourth and two sensoria on seventh segment; forewing pad 0.673 mm long and nearly two times as long as wide; tibia tarsus articulation is not well defined; tarsus end with two claw like spines; abdomen 0.826 mm long and 0.949 mm wide, caudal plate nearly twice as wide as length of abdomen, circum anal pore wing 0.269 mm wide and bean shaped.

Third instar nymph: Body 1.080 mm long and 0.880 mm wide; antenna 0.430 mm long, twice as long as width of head; five segmented, first two segments robust, as long as each other; terminal longest bearing two sensoria and two apical spines of equal length, one sensoria on third segment; wingpad demarcated, 0.410 mm long and 0.180 mm wide, twice as wide as long; margins surrounded by number of simple setae in the ratio of 2:1; abdomen 0.500 mm long and 0.670 mm wide; caudal plate 0.380 mm long, nearly twice as long as the width of the abdomen; circum anal pore wing 0.200 mm wide, surrounding the anal opening.

KEY TO THE SPECIES OF *Trioza* FOERSTER

1. Head sub horizontal, genal cone long ....*Trioza longiantennata* Mathur

- Head deflexed genal cone small 2

2. Genal cone very small sparsely pubescent, divergent and bluntly round at apex ....*T. bifurgata* Mathur

- Deeply deflexed downward genal cone, almost triangular, broadly rounded at apex................... *T. yelagiriensis* sp. nov.

3. DESCRIPTION OF ADULTS

2. **Trioza yelagiriensis** sp. nov. (Fig. 3)

Colour: General colour dark brown, antenna light brown of the segment first to eighth, ninth and tenth segment dark brown, wings hyaline, transparent, veins brown, legs light brown, abdomen dark brown in colour.

Head: Head including eyes smaller than thorax, moderately pubescent, vertex serrate, wider than long, with two foval impressions near posterior margin, both the corners of anterior margin projected forward, anterior ocellus not clearly visible from above, deeply deflexed downward, divergent, serrate, eyes large and hemispherical.

Antenna : Antenna long, slender, 1.030 mm long, first segment longest, fourth longer than rest of other segments, fifth smaller than sixth, seventh as long as eighth, last two segments small and slightly wider, terminal segment bearing two setae almost in equal length, sensoria present on segments fourth, sixth, eighth and ninth.

Leg: Leg long, pubescent, femur, tibia and tarsus beset with minute points, femur smaller than tibia, tibia with subapical setae, three spine like tooth and comb of long thick setae at its apex, apical tarsus longer than basal tarsus with two claw like spines.

Wings: *Fore wing:* Long and ovate, angled at apex, thrice as wide as long, basal vein longer than radius and cubitus, medium almost twice as long as cubitus, radial sector short and curved to casts; first marginal cell longer and wider than second marginal cell, veins with minute setae, wings hyaline.

Hindwing: Transparent, hyaline with row of setae at apex of costal region.

FEMALE : Genitalia smaller than abdomen, pubescent, ventral plate longer than dorsal plate, dorsal plate broad basaly and narrow apicaly, 500 μ long, tip of the dorsal and ventral plate with bunch of thick setae, circum anal pore ring placed on dorsal plate consisting of two rows of pores, inner row with elongated with elongated and outer with short round pores, ovipositor short.

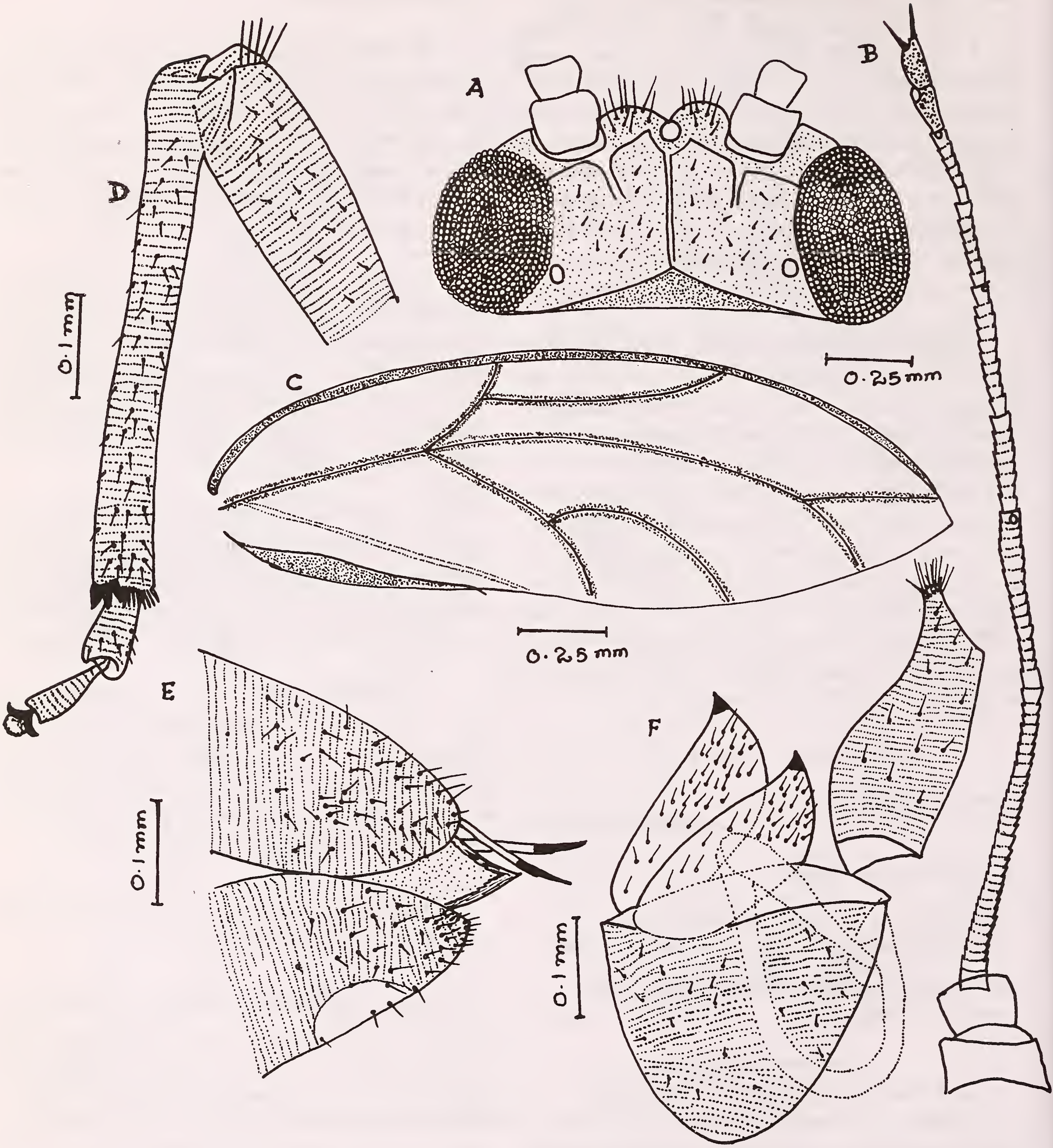
D
A
B
0.1 mm
0.25 mm
C
0.25 mm
E
F
0.1 mm
0.1 mm

Fig.3. *Trioza yelagiriensis* sp. nov.
A. Head; B. Antenna; C. Fore wing: D. leg; E. Female genitalia; F. Male genitalia.

MALE: Genitalia smaller than abdomen, pubescent, hypandrium triangular, paramears longer than anal valve, with thick apex, apex of the anal valve with row of long setae, aedeagus 250 u long and end with spoon like structure.

Measurements (in mm) : FEMALE (MALE)

Body length	:	3.250 (2.968)
Width of head	:	0.620 (0.600)
Width of vertex	:	0.320 (0.300)
Length of forewing	:	3.304 (2.998)
Length of femur	:	0.500 (0.500)
Length of tibia	:	0.800 (0.800)
Dorsal Plate	:	0.600
Ventral plate	:	0.380
Hypandrium	:	(0.220)
Analvalve	:	(0.250)
Paramer	:	(0.260)
Aedeagus	:	(0.250)
Length of antenna	:	1.050 (1.030)

Host plant	:	*Ficus bengalensis* Linn. (Moraceae)
Locality	:	Yelagiri hills, North Arcot, Tamil Nadu (1600 m).
Type	:	Holotype female, allotype male mounted on slides, paratypes one female and one male.
Date of collection	:	May 25, 1985.
Collected by	:	K. Thenmozhi.

Remarks: *Trioza yelagiriensis* sp. nov. is closely related to *Trioza bifurcata* Mathur (Mathur 1975) in having short radial sector curved to costa, more than one mm long antenna, hind tibia with a strong and conspicuous apical spur, but is distinguished from *T. bifurcata* in having almost triangular broadly rounded at its apex and deeply deflexed downward genal cone, hind tibia without apical black tooth. Out of 29 species reported under the genus *Trioza* in India, 19 are gall formers. The present report on *T.yelagiriensis* sp. nov. adds to the list of gall forming species. This is the first time a gall maker from the genus *Trioza* is reported on *Ficus bengalensis* (Moraceae).

4. DESCRIPTION OF THIRD TO FIFTH NYMPHAL INSTARS

Fifth instar nymph: Body elongate, oval 2. 601 mm long, head and prothorax completely fused and prothorax separated by a membrane from meso - and metathorax; meso- and metathorax well demarcated; head 0.750 mm long, 54 number secta setae surrounding margin of head, antenna 0.270 mm long, nearly three times shorter than the width of head, six segmented, four sensoria present in the segment third, fourth, fifth and sixth; wing pad well developed, triozine form, fore wing and hind wingpad well demarcated, fore wingpad 1.150 mm long and 0.370 mm wide and each of margin surrounded by 122 number of secta setae and hind wingpad margin by 18 number of secta setae; leg 0.970 mm long, tibia tarsus articulation well defined, abdomen 1.220 mm long, margin of the abdomen surrounding 130 number of setae, circum anal pore ring placed ventral side of the abdomen consisting of double ring of pores.

Fourth instar nymph: Body 1.560 mm long and 1.120 mm wide, identical to that of fifth instar except in the size and number of setae present in the margin of body; head 0.720 mm wide, antenna 0.160 mm long five segmented with three sensoria present in the segment third, fourth and fifth; legs robust and stout; wingpad well developed; abdomen 0.920 mm wide, weakly sclerotized on the dorsal side, ventral side membranous, circum anal pore ring placed on the ventral side of abdomen, the margin of head, wingpads and abdomen surrounding 42, 103 and 120 number of secta setae.

Third instar nymph: Body oval shaped, 0.520

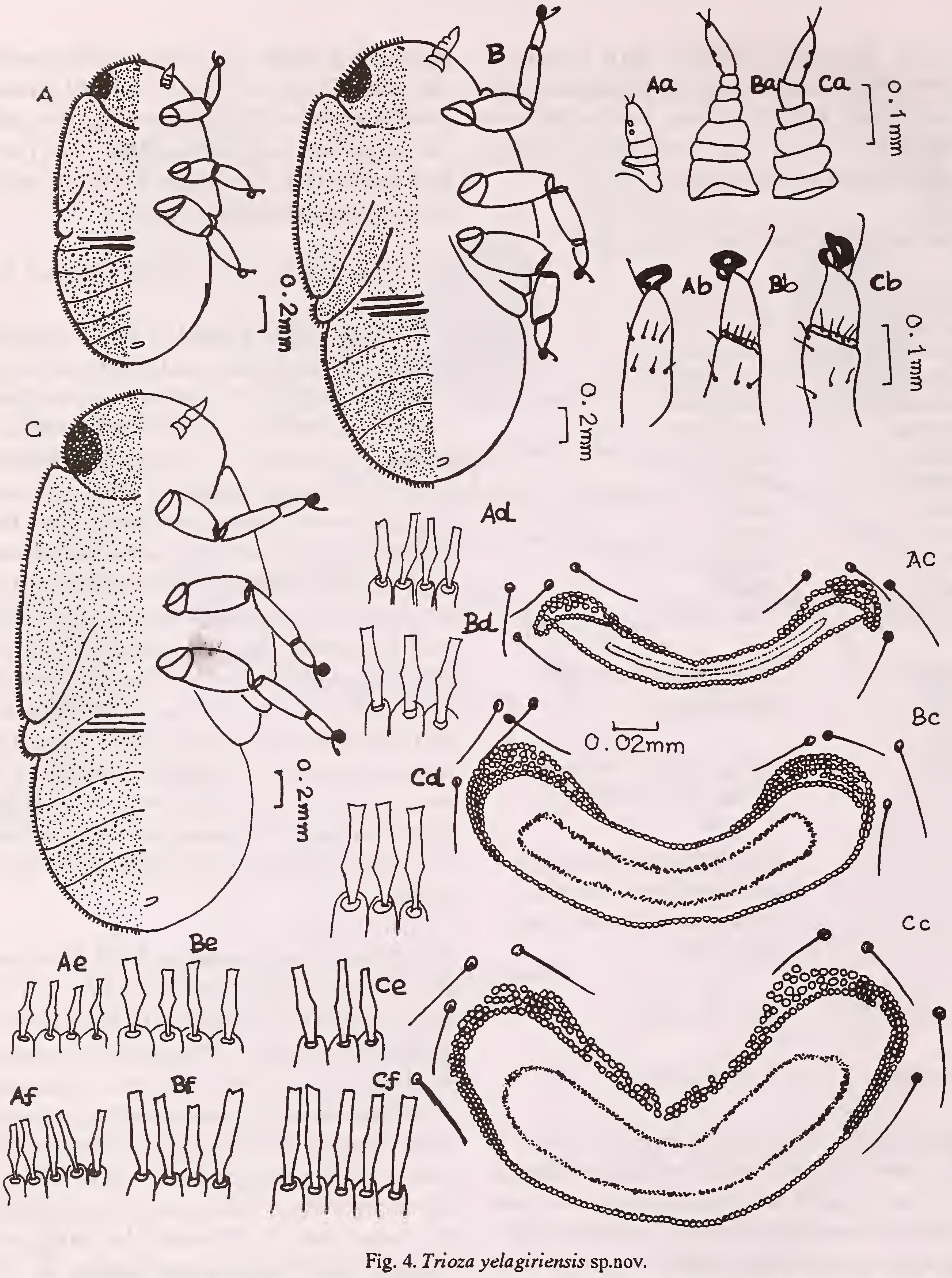
A
B
C
Aa
Ba
Ca
0.1mm
Ab
Bb
Cb
0.1mm
0.2mm
0.2mm
0.2mm
Ad
Bd
Cd
AC
Bc
Cc
0.02mm
Ae
Be
ce
Af
Bf
Cf

Fig. 4. *Trioza yelagiriensis* sp.nov.

A. Third inster nymph: Aa. antenna; Ab. leg; Ac. anal pore ring; Ad. marginal secta setae of abdomen; Ae. marginal secta setae of head; Af. marginal secta setae of thorax. B. Fourth instar nymph: Ba. antenna; Bb. leg; Bc. anal pore ring; Bd. marginal secta setae of abdomen; Be. marginal secta setae of head; Bf. marginal secta setae of thorax. C. Fifth instar nymph: Ca. antenna; Cb. leg; Cc. anal pore ring; Cd. marginal secta setae of abdomen; Ce. marginal secta setae of head; Cf. marginal secta setae of thorax:

mm long and 0.829 mm wide, head 0.520 mm long, wider than the length of antenna (0.150 mm) the margin surrounded by a row of 36 number of secta setae, antenna two segmented, triangular shaped, placed ventrally, two sensoria in segment second and third; wingpad not well developed, anterior wingpad 0.570 mm long, margin of fore wing and hind wingpad surrounding 60:14 number of secta setae: abdomen 0.765 mm wide with 77 number of secta setae surrounding the margin, circum anal pore ring placed on central side of abdomen consisting of double ring of pores.

ACKNOWLEDGEMENTS

We thank Dr. B.V. David, Director, Coromandel Indag Group, Dr. I. D. Hodkinson, Department of Biology, Liverpool Polytechnic, U.K. and Mr. J.H. Martin, Department of Entomology, British Museum (Natural History), London for confirming the identity of Psyllids, and the Botanical Survey of India, Coimbatore for identifying the host plants. Thanks are due to Mr. S. James Fredrick, Chairman, *Fippat* for facilities provided and to CSIR for financial assistance.

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OBITUARY

PROF. K.K. NEELAKANTAN

(1923 - 1992)

The passing away of Prof. K.K. Neelakantan on 14th June 1992 was a great loss to ornithology. Prof. Neelakantan was an unassuming but excellent ornithologist. His thirst for knowledge of birds remained unquenched till his last breath and it was for ornithology that he devoted most of his life time.

Born on the 14th April 1923 at Kavassery, Palghat District, Kerala, Prof. Neelakantan had his early education in Mysore, where his father worked as a veterinary doctor. He was later sent to Kerala to continue his schooling. He passed intermediate at the Malabar Christian College, Calicut and did B.A. Hons. in English literature at the Madras Christian College, Tambaram.

He started his career as a lecturer in English literature at the Government Training College, Rajamundry, Andhra Pradesh and later 'migrated' to Kerala and served as Professor of English Literature in several colleges. He retired as the Head of the Department of English Literature from the University College, Trivandrum in 1978.

Prof. Neelakantan became interested in birds from a very young age. He was a very keen and competent observer of birds and their behaviour. He paid great attention to the identification of birds and interpretation of their behaviour. He meticulously noted down his observations in thick, bound notebooks and at the time of his passing away, he had well over 100 such note books. Through considered to be an authority on the birds of Kerala, Prof. Neelakantan's interests were more on observing the behaviour and habits of the birds around him than on their Taxonomy, though he was equally proficient in both.

Prof. Neelakantan discovered the largest breeding colony of Spotbilled Pelicans at Aredu, Andhra Pradesh in 1947. He brought this Pelicanry to the attention of the scientific community by publishing a note on its discovery in JBNHS 48: 656-66 (1949). Following this, he was entrusted by the A.P. Wildlife Department to chalk out a conservation strategy for the pelicanry. The Spotbilled Pelican was perhaps one of his most favourite birds and he was concerned about its future, especially after the Aredu Pelicanry was abandoned by the birds a few years after its discovery. He wrote in several conservation journals about his fears about the pelican and also spoke about it in naturalists' get-togethers.

His studies on bird behaviour have added valuable information on the natural history of various species. He published over forty notes/papers in the *Journal of the Bombay Natural History Society*, besides several articles in *Newsletter for Birdwatchers* and other scientific and popular journals and magazines. He wrote under the pseudonym 'Induchoodan' in Malayalam.

Prof. Neelakantan's greatest contribution to ornithology was his publication in Malayalam "*Keralathile Pakshikal*" (Birds of Kerala). This was published first in 1958 by Kerala Sahithya Academy, Trichur. An enlarged, revised edition was brought out in 1986 which describes 260 species and has fifty colour and black-and- white plates, executed by the author himself. The book contains several original observations by the author on the behaviour etc. of birds. The book won him not only awards like the Kalyani Krishna Menon Prize (in 1960) and the honour of being one among the three Malayalam books selected for an Indian Book Exhibition in Moscow (in 1963), but also popular acclaim and appreciation. As Dr. Salim Ali himself has aptly put it, ".....(K.K. Neelakantan's) writings in

Malayalam.... are predominantly responsible for the awareness, appreciation and general interest in birds that prevail among the public in this bird rich and fascinating area today..."

Prof. Neelakantan has also published three other books in Malayalam '*Pakshikalum Manushyarum*' (Birds and Men) (1979, Macmillan India) - an introduction to bird life and bird watching intended for children, *Pulluthottu Poonara Vare* (from Grass to Flamingo) - (1986, Kerala Sastra Sahitya Parishad)- a collection of articles on nature conservation and different aspects of birdlife and *Pakshikalude Arhbutha Prapancham* (Wonderful World of Birds) (1987, Kerala Sastra Sahitya Parishad) - an abridged version of *Pakshikalum Manushyarum*. These books also were well received by the public and also won various awards. Several people took to ornithology inspired by his writings.

However, his most awaited publication - '*A Book of Kerala Birds*' (Part 1) which describes over 90 taxa of birds which have been added to the Kerala list since the Publication of Dr. Salim Ali's '*Birds of Kerala*' (1969) is being published posthumously. Prof. Neelakantan was giving finishing touches to the manuscript of this publication at the time of his death and it is really unfortunate that he did not live to see it in print. Part II of this work will include changes in the status of birds in Kerala, new information on behaviour, distribution, nesting etc. mostly, his own work.

Prof. Neelakantan was the founder/President of the Kerala Natural History Society, Trivandrum. He was also the Vice-President of Prakruti Samrakshna Samithi, Trivandrum. Besides, he also served as a member of the Kerala wildlife Board and as a member, Kerala State Committee, World Wide Fund for Nature-India.

Prof.Neelakantan was also an artist, and illustrated his own books. His paintings of common birds of Periyar Tiger Reserve (Thekkady) are exhibited in the Reception Office of the Sanctuary.

In the death of Prof. Neelakantan, India has lost an extraordinary Ornithologist and naturalist. We hope his life and works would continue to inspire several newcomers to this field in the years to come.

V. SANTHARAM, AND C. SASI KUMAR

REVIEWS

1. BIRDS : SUPPLEMENT TO WEALTH OF INDIA. Vol 2B. pp.109+47(28 x 22 cm), with twenty two colour plates . New Delhi, 1990. Publications & Information Directorate, CSIR. Price Rs.125, $45.00, £30.00.

Bird watching has now evolved into a popular hobby in India. Various books both by Indian and foreign authors cater to the needs of Indian bird watchers. These books generally cover field identification, behaviour and biology of Indian species. The Information about the economic aspect of our avian species are usually very sketchy in these books. The present publication on birds by CSIR partly fills this lacuna. The book is a compilation of information available on economic importance of Indian birds. As a supplement to the Wealth of India part 2B it primarily looks at birds as an "economically important commodity". The approach is appropriate to cover the scope of the book. The book deals with various economical aspects of birds and classifies them as game birds, plumage birds, song birds, cage birds, scavengers, birds of prey, birds used in medicine, birds with economically important nests, birds in agriculture, horticulture and forestry.

The text is covered in 15 chapters. The first chapter on classification of birds has been contributed by none other than Dr.Salim Ali. The classification is not very technical but more specific to Indian species and groups them into various families with explanations about their morphological and behavioural differences. The subsequent chapters deal mainly with the economical aspects of Indian avifauna. The chapter on Game birds gives an exhaustive list of Indian birds valued as trophies,for table and for sport. In the context of Wildlife Act and the complete ban on hunting this list is redumdant and is purely of academic interest. It nonetheless provides an insight to the fact as to how game birds are more endangered due to human action as compared to other species. The remark on Falconry being a dead sport in India as *unfortunate* is quite unwarrented, especially considering the present status of our raptors. The chapters on plumage birds covers the birds whose plumages are economically important. It, however, does not indicate the mode of collection of these plumages. One is particularly interested to know the effect that, the established trade in Peacock feather will have on the population of our national bird.

The book also provides a list of Indian birds economically valued as song birds. The Grey wing Black bird tops the list as the best songster. The chapter also covers mimicry amongst calls of Indian birds. It lists Rufousbacked shrike, Black headed shrike and the southern Indian greybacked shrike as among the best mimics. Together these three have been reported to mimic about 32 species of birds. The chapter on cage birds provides names of Indian birds valued as pets and also those trained for fighting falconry & fishing. There is a separate chapter on scavengers amongst Indian birds which also provides information about their ecological role. There is also an account of the Birds of Prey and their feeding habits. The chapter on birds in medicine lists the various reported medicinal uses of birds. There are some funny entries "like meat of cuckoos for mental diseases or the pelican feet for rheumatism". The authors, neither do not mention how authentic are the claims about the medicinal values nor do they provide the source of these claims. The chapter should have made more explicit the scientific basis of these claims to avoid false claims and even unnecessary slaughter of these birds.

The book also provides an exhaustive list of birds as cross pollinators, controllers of insect pests and in dispersal of seeds. Additionally the book provides a concise account of methods used for controlling bird hazards in aviation. There is a separate chapter on bird migration pattern in India. It describes avian migrants of India in 3 groups-(1) Winter migrants from palearctic region; (2) Winter migrants from Himalayas; (3) Local migrants. The last chapter on conservation deals with the status of various bird species in India and lists them as endangered, vulnerable and rare. It also gives a short account of various measures being undertaken to conserve our avifauna. The book at the end incorporates a list of National parks, sanctuaries and other areas where birds are abundantly found. The book has 3 indices one for latin names, one for english names and another for vernacular names.

The colour illustrations run to 22 plates but are of poor quality and at some places do not reflect the natural colours of the birds. They are not free of mistakes either. Grey heron has been labelled as Purple heron. Some of the birds illustrated have been labelled casually, for instance, spotted owlet is labelled as owlet, large pied wagtail is labelled as Wagtail. The inclusion of White and Black Swans in the illlustrations is clearly out of place in a book dealing with Indian species. In fact the birds are mentioned only in classification.

As mentioned earlier the book is a compilation of various information and facts published elsewhere. The book at several places is merely a list of birds. The book will find its readership amongst experienced bird watchers, research workers in ornithology and others seeking information on economic ornithology of Indian avifauna. The books style of presentation may not enthuse uninitiated laymen and beginners in bird watching.

SHASHI MENON

2. NATURE GUIDES- COMMON BUTTERFLIES OF INDIA. By Thomas Gay, Isaac David Kehimkar and Jagdish Chandra Punetha. pp.67 (24 x 14.5 cm), with eight colour plates and 70 black-and-white text-figures. Bombay, 1992. Oxford University Press. Price Rs. 60/-.

During the early days of the WWF nature camps, birds were the unchallenged centres of attention for most of us. Mammals were seldom seen and other groups were, for the most part, unknown quantities. The world of an amateur naturalist in the early 1980s consisted primarily of birds, occasional mammals, some reptiles, insects and plants and a few oddities like the flying frog. With time, this highly skewed emphasis on mammals and birds has been remedied to a large extent with the less visible animals getting their due share of attention. Every animal has its own fascinating tale to tell about its role in nature's scheme of things. While bird-watchers still dominate the scene, it is heartening to see more and more “wildlife watchers” now a days.

The principal reason for this state of affairs was the total lack of field guides for the amateur. Dr.Salim Ali’s books on Indian birds had gone a long way in nurturing the appeal that birds have for most people. His series of books were addressed to a wide variety of bird-watchers from the rank beginner to the professional ornithologist. Other animals did not have the benefit of an erudite voice selling them to the layman in a popular manner.

When I developed an interest in butterflies six years ago, there were only two identification books in existence. Neither was easily available nor were they meant for the beginner! The pictures were terrible and butterflies had to be identified from descriptions liberally sprinkled with unknown technical terms. An "easy" butterfly like the Peablue took two whole days; compare that with the ten minutes it will take you with a good beginner's guide which has a photograph of it. If you can get a good beginner's guide, grab it!;It will save you a lot of time and effort during the early days.

The WWF-India has brought out the Common Butterflies of India as part of its series of Nature Guides with the avowed purpose of inculcating interest in our flora and fauna to promote the cause of nature conversation.

It is the only identification guide available for the beginner and the casual observer who wishes to know about the butterflies he sees around him. The authors have made it a point to use non-technical language where possible. A glossary as well as several figures explain the unavoidable technical terms used in the text. The introduction is quite comprehensive and gives a wealth of general information on butterflies. All the butterflies dealt with have been illustrated with many photographs (both colour and black & White) and sketches. The butterflies have been grouped into families with emphasis on their characteristic features and habits.

In my opinion, the major feature of this book is its emphasis on observing and identifying live butterflies. It is perhaps the only guide without a chapter on collecting butterflies. Butterfly guides throughout the world give the impression that collection is essential for their study. Many entomologists turn their noses up at identification of live butterflies. Some butterflies are tough to identify without a specimen in hand; But "tough" is not the same as "impossible"! Undoubtedly, specimen collection has its proper place in a scientific study. But many studies, including rigorous scientific ones, do not require it. With some practice, all the common species and many rare ones can be identified in the field. If required, one can catch some of the tough customers in a butterfly net and inspect them from close and release them after identifying them. Close-up photographs or line sketches along with notes on their behaviour and habitat along with some patience will make for sufficiently accurate identifications and provide you with an engrossing hobby without having to bloody your hands and soul! You can always take your notes and photographs to the nearest butterfly collection and compare them with the dead specimens. It is only proper that dead butterflies are utilised to avoid killing more of their kin!

Some of the other plus point of this book are the various tips that the authors give about rearing butterflies and photographing them. A butterfly coming out of the chrysalis is a fascinating event and well worth the effort and the patience that is required to see it.

There are several points on which the authors could have done better. Hopefully, these will be rectified in future editions. To be fair, some of them were no doubt unavoidable and occasioned by constraints of time and economy. It is not easy to bring out an inexpensive book which has so many colour photographs and material.

While the colour photographs are reasonably good (though not in the same league of many of Isaac's other photographs) the black & white ones as well as the sketches leave much to be desired. I could not see the Indian sunbeam or the Common castor in the sketches, even after reading the caption! And some photographs (e.g. the Black prince and the Common crows on *Heliotropium*) do not serve any purpose. Several such figures could have been avoided. Sketches with shading seem to be particularly bad while the plain line sketch of the Tree nymph is much better. There's not much use in shading the white parts of a butterfly (sketch of the female yellow orange-tip) in fact it is misleading. The sketches of the handsome swallow-tails in the main text are superfluous considering the identical colour plate on the back cover.

A few more lines of description were necessary for the Blues and the Browns which consist of many groups of closely related species. Mention could have been made of allied species, warning the reader of the pit-falls of casual identification. In the case of the Gram blue it would perhaps have been more appropriate to show a photograph of the underside and describe the upper surface in just one line.

By and large the selection of butterflies is fairly representative. But considering some of the rarer butterflies shown, some common ones like the Forget-me-not and the chestnut bob (perhaps the commonest skipper of the woodlands and one of the easier ones to identify) and a few of the rarer ones like the Red Helen and the peacocks (which are far commoner than the Apollos anyway). Several other groups of butterflies could also have been mentioned in the passing without illustrations. Groups like the blue crows and the royals are easy enough to identify (though not the individual species) an a line or two regarding them would have sufficed. Closely related species could have been mentioned while describing some species, like a one line description of the Crimson Tip while describing the Orange Tips.

The authors should have included a section on the options a reader has when confronted with a species not in this book. A list of the more comprehensive guides and the butterfly collections in this country would have been of immense help to students who wished to go beyond this book. Considering that the more detailed books on butterfly identification follow the older system of nomenclature the older Latin names ought to have been mentioned to facilitate cross reference.

That I've spent more time on the shortcomings of the book is not an indication of my evaluation of the book. This is an excellent book for identifying butterflies, and specially recommended to beginners. It is well worth its cost even if it was not the only book available to the non-specialist. If presenting this book to children, you may well end up presenting them with an engrossing and life-long hobby!

The last decade has seen a ground-swell in the number of people who have embraced nature-watching as a hobby; even better is the realization that there is more to wildlife than a tiger or a Siberian crane; that much maligned creatures like the spiders and snakes lead lives as fascinating as that of their more visible brethren and that every part is essential to the whole. In my experience, where animals are concerned, familiarity does not breed contempt; quite the contrary, it nurtures a fascination for the natural world. Easily available inexpensive guides would go a long way in making popular attitudes friendlier towards out environment. Ultimately it is only a change in public attitudes which will decide the sort of environment we will inhabit. I shall end this review on a note of hope that this guide to butterflies is not the last of the series devoted to various groups of little known animals.

RAMANA M. ATHREYA

MISCELLANEOUS NOTES

1. HOME RANGE OF HANUMAN LANGUR (*PRESBYTIS ENTELLUS*) IN FOUR HABITATS IN JAIPUR, INDIA

The Hanuman Langur (*Presbytis entellus*) lives in a wide range of ecologically diverse habitats in India, (Prater 1980). In Jaipur, this species occurs in a variety of habitats like forests and urban areas (temple, tourists spots and residential area, Mathur and Ram Manohar 1987). The size of langur groups varied in these habitat types. At Jagatpura (forest/ village habitat) the group size was large with 118 individuals, but in the temple area (Govindeo temple) and the tourist area (Amber Fort) the langur groups had each 42 animals respectively. At Brahmpuri (residential area) 80 langurs were counted in a single Unimale group. The home range of the langur groups in the four habitats was studied by following them from 6.00 a.m. - 6.00 p.m. for nearly 30 days during the months January, February, March, April, 1986.

TABLE 1

HOME RANGE IN SQ. KM. OF UNIMALE LANGUR GROUPS IN DIFFERENT HABITATS

Sl.No.	Place	Group Name	Habitat	M.C.P.	C.P.	95% Eclipses	Grid	Average
1.	Govindeo Temple	Gum -I	Temple	0.3771	1.1786	1.1007	1.3923	1.012
2.	Amber Fort	Aum - I	Tourist Area	0.3771	0.1737	0.7393	0.2457	0.3739
3.	Brahmpuri	Gaum-I	Residential Area	0.6634	0.1956	1.766	1.218	0.96075
4.	Jagatpura	Jaum	Forest/Village	2.3803	0.2310	6.0674	2.8503	2.8821

M . C. P. = Minimum Convex Polygon. C. P. = Convex Polygon.

The outermost location points of the langur group sightings were marked on the detailed enlarged maps of each habitat and later these points were joined by straight lines. Totally four methods were used to calculate the home range. Three of them were done using McPal Software (specially programmed for home ranges) on IBM personal computer. The fourth one was Grid Method (1 cm x 1cm grid). The average of the four different values was calculated as home range (Table 1). The home range of a Unimale langur group at Jagatpura Forest/ Village habitat was larger than that of the other groups . The Unimale langur groups at Govindeo Temple and Amber Fort-tourist area had similar sized home ranges. The Brahmpuri-residential area group had a medium sized home range. Group size, availability of food, proximity of neighbouring group are the factors influencing the size of the home range of langurs (Lindburg 1971, Poirier 1968). It is known from other research sites that populations living in areas of low food availability tend to have larger home range than those living in areas where food is more abundant (Yoshiba 1968, Pirta and Singh 1982). At Jaipur also the large Unimale langur (Jagatpura) group had a larger home range and lived in a poorer resource area when compared to the other groups living in other habitats.

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July 5, 1993

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2. STUDY OF ACTIVITY PATTERN IN *PRESBYTIS ENTELLUS* AT AMBAGARH RESERVE FOREST, JAIPUR

INTRODUCTION

A thorough understanding of activity patterns of any primate species is crucial to understand its behaviour and any change in it due to physical, mechanical and climatic factors as well as human interference.

In the field, the frequency of the majority of social interactions, especially aggression among primates is related to food availability and distribution (Chalmers 1968). Changes in food availability may also affect the day range (DeVore and Hall 1965, Altmann and Altmann 1970). In case of *Presbytis entellus* foraging and resting are its two most prominent diurnal activities (Oppenheimer 1973, Yoshiba 1967). The time spent on other interactions would increase when time spent on foraging decreases (Crook 1970) but when there is decrease in food availability, feeding becomes the most time consuming activity (Teas 1978).

The activity pattern of *Presbytis entellus* has been studied at Orcha and Kaukori (Jay 1965), Dharwar (Yoshiba 1967), Gir Forest (Starin 1973), Mount Abu (Hrdy 1974), Singur (Oppenheimer 1973,1977), Shimla (Sugiyama 1976). A detailed description of activity pattern in *Presbytis entellus* was given by Oppenheimer (1977) regarding their diurnal as well as seasonal changes.

STUDY AREA

This study was carried out between October 1988 and September 1989 at Ambagarh Reserve Forest (ARF) (26°55' N, 75°55' E) situated approximately 7 km. from Jaipur city on the north-eastern side. ARF has dry deciduous semi-arid forest dominated by *Anogeissus pendula, Maytenus emarginata, Holoptelia integrifolia, Parkinsonia aculeata* and *Acacia tortilis*. The year was demarcated into three seasons, namely winter (October-February), summer (March-June) and monsoon (July-September). Average maximum annual rainfall in the region is approximately 600 mm. ARF includes temples and a village, therefore, provides a semi-wild environment to langurs. The monkeys got both natural vegetation and provisioned food given by devotees, they occasionally fed on ticks, lice and grasshoppers (Mathur *et al.* 1990).

METHODS

One unimale bisexual group (G III) with 119 individuals (1 adult male, 49 adult females, 7 sub-adult females, 34 juveniles and 28 infants) was selected. The observations were made using the scan sampling technique (Altmann 1974). Observations were made between October 1988 and September 1989. The group was scanned on the 10th, 21st and

28th days of each month. Observations were made between 1200 and 1800 hrs. Each study consisted of 25 scan samples. Adult, subadult and juveniles were scanned. Three activities, namely group movement, grooming and feeding were noted. An activity was recorded only when it leasted for at least 5 seconds. As the group was large, each scan period was of 20 minutes. This was followed by 5 minute intervals. All the group members were scanned. In the present study morning was considered as between 0700 and 1100 hrs. afternoon as between 1101 and 1600 hrs. and evening as between 1601 and 1800 hrs.

RESULTS

Feeding: There was a distinct seasonal variation in time spent in feeding. During winter there were two feeding bouts, one in the morning and the other in the afternoon. In summer though some feeding took place in the morning and evening also, to avoid excessive heat, langurs preferred feeding in afternoons between 1500 hrs to 1600 hrs, whereas in wet months, again two feeding peaks appeared, one each in morning and evening (Table 1).

Grooming: In winter, there were three peaks of grooming, i.e. one each in morning and afternoon and the third in the evening. During summer maximum grooming occurred in morning and afternoon (between 1000 to 1300 hrs.) During rainy season, grooming was at its peak in the afternoon (Table 1).

Group movement: Langurs moved maximum during winter, in this season three peaks appeared, one in morning (54.0%) and two in the afternoon. During summer movement reached at its highest in the afternoon (between 1400 to 1500 hrs). Langurs move during summer because vegetation is scarce and thus they have to move more to forage. In rainy season one peak each was noticeable in morning, afternoon and evening (Table 1).

TABLE 1

PERCENTAGE OF THE SPENT ON THREE MAJOR ACTIVITIES BY *Presbytis entellus*

Time	Feeding			Grooming			Group Movement		
(hrs)	Oct.-Feb. (Winter)	March-June (Summer)	July-Sept. (Rains)	Winter	Summer	Rains	Winter	Summer	Rains
0700-0800	13.70	30.25	48.75	32.05	40.25	32.50	54.00	29.00	18.75
0800-0900	41.50	29.25	54.00	30.50	34.25	17.75	28.00	26.75	27.75
0900-1000	40.25	27.50	27.50	24.50	35.50	32.00	34.50	28.75	41.00
1000-1100	36.50	16.25	17.50	41.75	46.25	51.25	20.25	37.25	31.25
1100-1200	15.50	20.75	17.25	41.75	56.00	52.25	44.00	24.00	29.75
1200-1300	31.25	21.50	20.25	32.75	47.75	29.00	46.50	29.00	30.25
1300-1400	38.00	25.75	22.50	24.00	42.00	47.25	38.00	32.00	28.50
1400-1500	33.50	31.25	25.25	20.50	21.25	30.25	46.75	49.75	41.75
1500-1600	30.75	61.25	57.50	28.25	01.25	06.25	42.00	37.50	37.15
1600-1700	31.00	57.50	52.70	40.00	10.00	05.25	30.00	35.00	43.00
1700-1800	27.25	32.00	27.50	41.00	31.00	38.75	31.00	39.00	33.75

DISCUSSION

Generally, the langurs of ARF were more active during winter season, for all three activities they had almost three peaks. During this season, very early mornings (before 0600 hrs) and late evenings (after 1800 hrs) were extremely cold (6° to 18°C) otherwise, during the sunshine hours, the winter days were warmer (18° to 24°C). On the other hand, during summer, the days became unbearably hot, and the langurs generally remained inactive throughout the day. Concentration of activities during mornings and late evenings were most evident among them. During monsoon, the langurs followed no set activity pattern. They spent maximum time in feeding, probably due to abundance of green foliage.

During summer activities were restricted to early mornings and late evenings, whereas, in winter they were most active during the middle of the day. Whenever there was an increase in feeding or group movement, there was a fall in grooming. Time devoted to any activity at a given time, varied in different seasons. Langurs spent more time feeding during rainy season. Group movement was greatest in winter. Langurs were least active in summer. A great deal of time was spent in grooming in all three seasons but at different time of the day.

The percentage of time devoted to any activity during a season and also at any given point of time in the day of a season, varied because langurs adapted themselves according to seasonal changes. In rhesus also, components of the eco-system have been reported to affect the majority of activities (Shukla *et al.* 1982)

May 31, 1993

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3.FOOD HABITS OF THE FISHING CAT *FELIS VIVERRINA* IN KEOLADEO NATIONAL PARK, BHARATPUR, RAJASTHAN

(With a text - figure)

INTRODUCTION

Ecological information not only on the fishing cat but also all other lesser cats of the Indian Subcontinent is scanty. No quantitative information is available on the food habits of fishing cat except the stray observations of Jerdon (1874), Prater (1965), Roberts (1977). According to Sankhala and Sharma (1985), fishing cat is limited only to Keoladeo National Park, in Rajasthan.

STUDY AREA

Keoladeo National Park, (27° 7.6' to 27° 12.2' N and 77° 29.5' to 77° 33.9' E) situated 50 km south of Agra has an area of about 29 km^2. The entire area is flat with a gentle slope towards the centre forming a depression of about 8.5 km^2 which is the main submersible part of the park. The water is drawn into the park through a canal from Ajan Bund during the monsoon (July-October) and it gradually recedes and the park dries up during summer (March-June), leaving only some pools in the deeper areas. Trees which are planted on the mound inside the wetland are being used by the colonial birds for nest building. For a detailed description of the study area, see Ali and Vijayan (1986).

METHODS

Scats were collected mainly from the banks of the waterspread area and also from the dykes which divide the aquatic area where fishing cats were seen. All the scats were washed, the contents dried and examined under the dissecting microscope. Major taxa of the animal matter were determined and whenever possible prey groups were identified. Hairs, bones, scales and feathers from the scats were identified with the help of reference samples of different animals collected from the park. Frequency

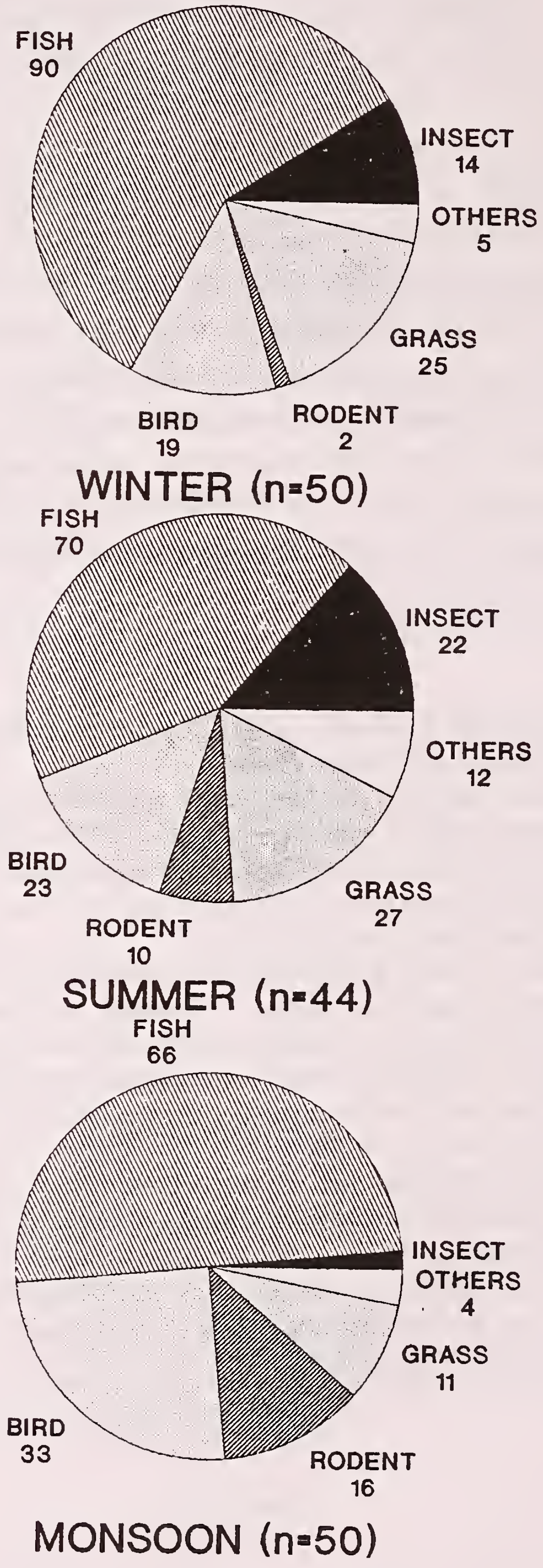

Fig. 1. Percentage of various food remains in the scats of fishing cat.

Table 1
PERCENTAGE OCCURRENCE OF FOOD REMAINS IN THE SCATS OF FISHING CAT IN DIFFERENT MONTHS DURING THE STUDY PERIOD

Month	No. of scats	Scats with fish remains	Percentage of scalts with the remains of					
			Insects	Fish	Birds	Rodents	Grass	Others
November1986	12	5	16.1	91.6	16.6	-	16.6	-
December	12	7	-	100	16.6	8.33	16.6	-
January 1987	11	7	18.18	100	-	-	18.18	-
February	15	4	20	66.6	53.33	-	46.6	20
March	13	2	30.76	76.92	53.33	-	38.46	-
April	10	3	20	70	40	20	40	10
May	10	2	20	80	-	-	20	20
June	11	2	18.18	54.54	-	18.18	9.09	18.18
July	12	2	-	41.66	41.66	16.6	8.33	8.33
August	11	2	9.09	63.63	36.36	18.18	-	9.09
September	12	2	-	58.33	41.66	16.6	16.6	-
Oct. 1987	15	8	-	100	13.3	13.3	20	-

Table 2

FREQUENCY OF OCCURRENCE OF FOOD REMNANTS IN THE SCATS OF FISHING CAT (N= 144)

	Occurrence	%
Insect	18	13
Fish	109	76
Bird	39	27
Rodent	13	9
Grass	31	21
Others	11	7

of occurrence of each item in the scats was recorded. Altogether 144 scats were collected from November 1986 to October 1987.

The gut contents of the fishing cat found dead outside the park on the Agra-Jaipur highway, 100 m from the park were also examined.

Results and discussion

Fish is the staple diet of the fishing cat in the park. Fish remains were present in the scats throughout the year and out of the 144 scats analysed, 76% had fish remains in them (Table 2). Monthly variation in the percentage of scats having fish remains ranged from 41% to 100%. It was the preferred food during winter (Fig.1).

Birds are the next preferred food (27%) of the fishing cat. During different months the frequency ranged from 13% to 53% although bird remnants were not present in the scats during January, May and June. It is difficult to give a valid reason for the absence of bird remains during these months.

Grass formed 21% of the food of fishing cat. It was present in all the months except August. The frequency ranged from 8% to 96% (Table 1). Among the three seasons (Fig.1), grass was preferred equally during winter and summer while least during monsoon.

Insects and rodents were seen in relatively small number of scats 13% and 9% respectively. The maximum number of insects in the scats was in summer followed by winter and the least in monsoon, while the maximum number of rodents was during monsoon followed by summer and the least in winter (Fig.1).

'Others' which formed 7% of the diet included seeds, hair, of hare and cattle, molluscs, scales of snake and monitor lizard *(Varanus bengalensis)*.

The fishing cat found dead just outside the Park on 15 Feb. 1986 was 66 cm in length (Head and Body) with a 24 cm tail. Its weight was 16 kg. and its stomach had fish, scales of snakes, feathers and insects.

Fish is the main food of the fishing cat in Keoladeo National Park. Bhattacharya (1989) reports in the Howrah district that the major food of fishing cat is fish, although goats, chickens and ducks of the nearby villages were killed. This is not reported at Bharatpur. Observations (n=12) made during moonlit night also confirm that they feed mostly on fish by entering water and scooping the prey with their paws. The visual observations also reveal that they feed on grasses and gerbills which are very common on the dykes of the aquatic area. The presence of cattle hair in the scats of fishing cat shows that they could scavenge (Haque 1988). The gut contents of the dead fishing cat also confirm that fish and bird are the major food. The other small carnivore which feed mainly on fish is Smooth Indian otter (Haque and Vijayan 1988).

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4. NEW RECORDS OF *MUSTELA* FROM KHUNJERAB NATIONAL PARK, PAKISTAN

The fauna of Khunjerab National Park (KNP), Pakistan has received little attention. KNP is a 2,269 km^2 alpine national park in Pakistan's northern areas. It shares a long border with the People's Republic of China. Until recently, there were no small mammals collected from KNP in Pakistani museums, and very few mammals collected from the immediate vicinity are found in foreign collections. As part of a long-term ecological study of Dhee Sar, a 4100-4300 m alpine meadow in KNP, I have been censusing the birds and mammals found there. Here I report the existences of two mustelids: *Mustela altaica*, the alpine weasel, and *M. erminea*, the stoat.

Based on museum records, Roberts (1977)

reported the existence of alpine weasels a little south of KNP, but the known range maps for stoats did not include the northern areas, and probable distributions included only a bit of the area around Gilgit and Skardu. Prater (1965) reported the stoat as found in Chitral, Hazara, and Kashmir, but not Hunza. The range maps in Corbet (1978) suggest possible sympatry around KNP, but his maps are not detailed enough to resolve it.

I lived at Dhee Sar for 242 days between May and September 1989-1991. During this time adult alpine weasels were periodically spotted (1989: 29 July; 22 August; 10 September ; 1990 : 21 July ; 23 July ; 1991: 4 July; 12 July; 11 August; 16 August), photographed once, and unambiguously identified. On no occasion did I spot juvenile alpine weasels.

On 9 July 1991, I spotted my first stoat in KNP. I positively identified it based on it's black-tipped tail. On 19 July 5 or 6 stoat pups and 1 adult were seen exploring a talus slope around our camp. They permitted me to approach closely and I photographed and videotaped them. On 26 July, I spotted an adult stoat with a Royle's high mountain vole (*Alticola roylei)* in its mouth running across a glacial moraine.

Both species of *Mustela* are sympatric in Dhee Sar, and indirect evidence suggests their diets may overlap. In 1989 and 1990, vole populations in our camp decreased when an alpine weasel was seen around camp, while in 1991, I observed the stoat eating a vole.

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5. A NOTE ON THE MORPHOMETRY OF GANGES RIVER DOLPHIN WITH COMMENTS ON ITS MORTALITY IN FISHING NETS

(With a text-figure)

INTRODUCTION

The Ganges river dolphin (*Platanista gangetica*) is distributed in the northern parts of the Indian subcontinent and inhabits the Ganges, Brahmaputra and the Meghana river systems and their major tributaries, from the tidal limits to the foot hills of the Himalaya (Prater 1948); the Garo hills of Meghalaya and the Cachar hills of Assam (Jones 1982). Once abundant, its population is now declining all over its range due to habitat loss, commercial exploitation and mortality in passive fishery (Perrin and Brownell 1989, Hussain and Choudhury 1992). Apart from this, construction of dams and barrages along the major tributaries have isolated its population into several pockets that eventually disappear (Haque 1976, Mohan 1989).

In recent years the Ganges River Dolphin is receiving considerable attention and investigation on their population status, ecology and behaviour have been steadily advancing (e.g. Pilleri 1970, Kasuya 1972, Kasuya and Haque 1976, Rao *et al.* 1989, Shrestha 1989, Hussain and Choudhury 1992). Nevertheless the extent of its mortality goes undetected. This paper presents a note on the morphometry of a Ganges river dolphin with comments on the extent of its mortality in fishing net along the Chambal river.

MATERIAL AND METHODS

The field staff of the National Chambal Sanctuary found a dead dolphin entangled in an illegal fishing net near Rajghat upstream of Agra-Bombay Highway bridge on October 10, 1988. The specimen was moved to Field Research station of Wildlife Institute of India at Deori 15 km away from the river. The specimen was checked thoroughly of any possible infection and injury. It was sexed, measured and then an incision was made at the abdominal region to collect the gut contents for analysis. The entire specimen was preserved in 10% Formaldehyde.

Following this in 1989 a survey was carried out and local fishermen were interviewed to asses the extents of mortality in fishing nets and other man induced disturbance factors that are detrimental to dolphin population in the National Chambal Sanctuary.

RESULTS

MORPHOLOGICAL DETAILS OF THE SPECIMENS

State : Freshly killed, No outer injury, infection or parasite; no decomposing effect at the time of collection or measuring.
Colour : Dark lead grey grading to lighter grey at the belly.
Sex : Sub-adult male
Weight : 17 kg
Total length : 117 cm
Tip of Upper jaw to centre of anus : 56 cm
Tip of upper jaw to centre of genital slit : 72 cm
Tip of snout to umbilicus : 50 cm
Tip of snout to flipper : 37 cm
Length of flipper : 15.5 cm (left), 13.0 cm (right, sign of deformity was found)
Width of flipper : 9.5 cm (left), 7.0 cm (right, sign of deformity was found)
Length of tail : 21 cm
Width of tail : 10 cm (fluke breadth)
Fluke span : 25.5 cm
Height of dorsal ridge : 1.2 cm
Tip of snout to eye : 21 cm
Tip of snout to blow hole : 23 cm
Length of blow hole : 4 cm
Length of snout : 12.5 cm
Number of teeth in upper jaw : 20 + 20
Number of teeth in lower jaw : 30 + 2 + 30

Extent of mortality in fishing nets: Table 1 shows the mortality of dolphins in fishing nets during 1988-1989. The result of the survey identified two areas (Fig. 1); one between Rahu Ka gaon (110 km) and Rajghat (195 km) and other at the end of the Sanctuary between Bhareh (410 km) and Panchnada (425 km). The extent of mortality in the

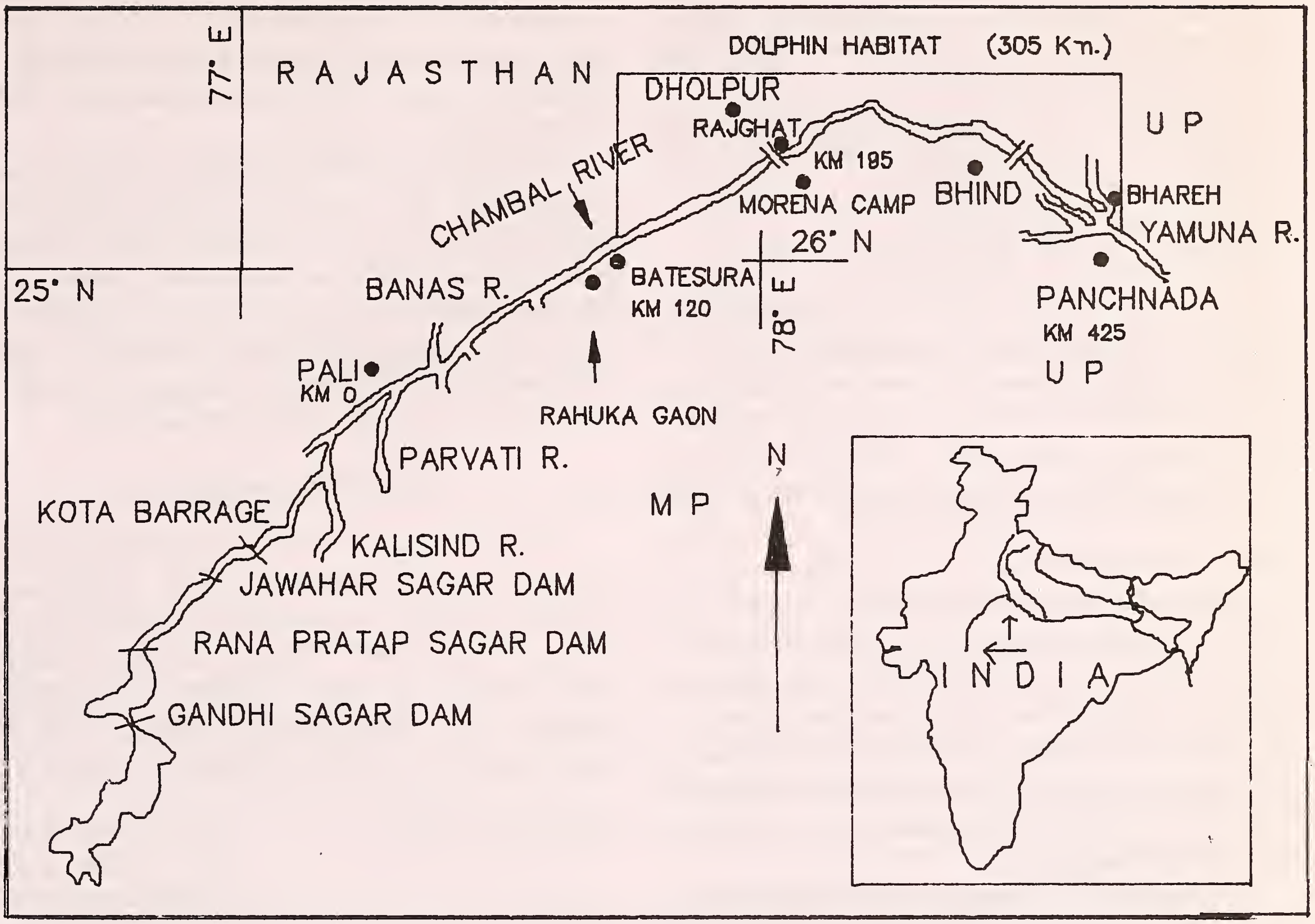
77° E
25° N
R A J A S T H A N
DOLPHIN HABITAT (305 Km.)
DHOLPUR
RAJGHAT
KM 195
MORENA CAMP
BHIND
U P
BHAREH
YAMUNA R.
26° N
78° E
CHAMBAL RIVER
BANAS R.
BATESURA
KM 120
PANCHNADA
KM 425
U P
PALI
KM 0
RAHUKA GAON
PARVATI R.
N
M P
KOTA BARRAGE
KALISIND R.
JAWAHAR SAGAR DAM
RANA PRATAP SAGAR DAM
GANDHI SAGAR DAM
I N D I A

Fig. 1. Chambal River with some of the important tributaries and land marks. Pali is river km. 0 and Panchnada is at river 425 km.

latter appears to be more frequent as stated by the fisherman but we did not find first hand evidence of it.

DISCUSSION

The National Chambal Sanctuary (570 km. long) was created in 1988 for the conservation of gharial (*Gavialis gangeticus*).

During 1985, Singh and Sharma (1985) had estimated an overall density of 0.079 dolphin/river from the sanctuary. The

TABLE 1

MORTALITY OF DOLPHINS IN FISHING NET DURING 1988-1989 IN NATIONAL CHAMBAL SANCTUARY (KM INDICATES RIVER KM FROM PALI)

Month & Year	Km	Village	Number	Wt.in Kg
Oct. 1988	195	Rajghat	1	17
Feb. 1989	125	Batesura	1	80
Mar. 1989	125	Batesura	1	7
Mar. 1989	135	Chinnoni	1	12
Oct. 1989	125	Batesura	1	35

dolphin distribution in the sanctuary is limited to 305 km stretch between Batesura and Panchnada (Singh and Sharma 1985, Rao *et al.* 1989, Hussain and Choudhury 1990, 1992). Thus the ecological densities calculated for the period of 1985 to 1992 were 0.147, 0.193, 0.180 and 0.183 dolphin/km. This indicates that the dolphin population is more or less stable. During our annual gharial, dolphin and other associated species survey we have frequently observed juvenile dolphins (5 % of the total sightings, Hussain and Choudhury 1992), indicating that the population is breeding. Besides the self regulatory mechanism of a population, the other most important factor that could affect the population is mortality of dolphins in fishing nets.

Platanista are adapted to live in turbid water. For their movement and locating prey they are dependent on echolocation. *Platanista* have double beam echolocation system which ensures wide coverage of their surrounding area (Pilleri 1979). However, the evidence of them getting entangled in fishing nets suggests that research is needed to find out why and how it occurs.

As evident from the mortality caused in illegal fishing nets, the solution for the long term conservation of Ganges river dolphin lies not only in the creation of new protected areas but also in minimizing fishing activities within protected areas. Therefore it is suggested to take stringent protection measures to control fishing by using gill nets in the Chambal river specially within the sanctuary.

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6. ANOTHER CONTINENTAL INDIA RECORD OF *ACCIPITER GULARIS*

The Lesser Sparrowhawk *Accipiter gularis* was known from India prior to 1980 only in the Andaman and Nicobar Islands (Ali and Ripley 1983, note that they called this form 'Eastern Sparrowhawk' *A. virgatus gularis*). Mees (1980) reidentified two specimens that were collected in continental India as *A. gularis*; one from Mhow in Madhya Pradesh and one from Point Calimere in Tamil Nadu. However, Mees questioned the location and date of the Mhow specimen. Salomonsen (1953) captured an *A. gularis* at sea in the Bay of Bengal. Most authorities now agree that *A. gularis* is a species distinct from *A. virgatus* (Mees 1980, Amadon and Bull 1988).

Our new record refers to a hawk captured in a mist net by Beehler and Shahid Ali at Wangasara in the Visakhapatnam Ghats of northeastern Andhra Pradesh (17° 50' N.; 82°30' E) on 28 September 1983 (Ripley *et al.* 1987). A single photograph was taken of this hawk by Beehler shortly before release. From this photo and the published notes, it has been reidentified as *A. gularis.*

The hawk, which was a second-year male, showed only a faint dark throat stripe, had barring on leg feathers, and had 4 dark tail bands that were narrower than the pale areas between bands. These features are characteristic of *A. gularis.* A male of *A. virgatus* would have had a thick dark throat stripe, spotted or solid coloured leg feathers, and three dark tail bands, each being as wide or wider than the pale areas between bands.

Measurements taken at the time of capture are not helpful in distinguishing whether it was *virgatus* or *gularis* as they are within the known range of both species.

Ornithologists and birdwatchers should be on the lookout for migrating or wintering Lesser Sparrowhawks, especially along India's east coast.

Acknowledgements

The Department of Forests and Environment, Government of India are thanked for permission to conduct field research in India, and the Department of Forests, Government of Andhra Pradesh are thanked for permission to work in their state. S. Ali and K.S. R. Krishna Raju assisted in the Research.

July 18, 1991

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7. BREEDING OF WHITE - EYED BUZZARD IN THE THAR DESERT

The White-eyed Buzzard (*Butastur teesa*) is well distributed over the Thar Desert, besides being found in open deciduous forests, scrub and cultivated lands of north and central India. They are commonly observed (single bird perched on electric/telephone posts) in Bikaner, Jodhpur and Jaisalmer districts.

A nest was located on 4 April 1991, 60 km from Bikaner on Pugal road on a telephone post 4.5 m above the ground. Made of twigs, it looked slightly larger than a crow's nest measuring 46 cm across and fairly deep. The nest was in the open and exposed though there were groves of thickly foliaged trees nearby. The nest was barely 10 m from the road and was surrounded by sand dunes. The female was incubating and my presence made it climb up on to the wires. The male soon arrived and even tried to mate. They uttered a harsh, piercing "Chirrr" which resembled the single alarm call of a spotted owlet. The nest contained one egg.

While on 7.4.91 there was three eggs of very light blue-green colour and appeared slightly larger than the eggs of a domestic hen. When I approached the nest the female flew off and sat on an exposed root of 'Phog' on top of the nearby dune. The male soon came and landed straight on the female and mated. "Chirr Chirr" calls accompanied the mating.

On 18.4.91 only two eggs were seen in the nest, (a few pieces of egg shells were found on ground. On 21.4.91 only one egg was left which the female continued to incubate. It hatched on 3.5.91 or 4.5.91, a minimum incubation period of 30 days was recorded. Salim Ali (HANDBOOK, 1968) mentions 19 days.

The one day old chick was pink skinned with white down, bill thick, yellow at the base and black at the tip. Legs were pinkish white. Its call was a very faint " Sirr, sirr"..... audible only up to 3 m. Eyes dark brown and appeared longish rather than circular. The male frequently brought small lizards which were common in the desert. Both parents brought prey such as lizards, rodents, grasshoppers etc. and fed the young. while the female incubated, the male was generally seen guarding the nest within 500 m. I once observed it chase a Short-toed Eagle up to 2 km.

By 23.5.91, when the chick was 19 days old, the wings had light and dark brown feathers, the primaries still partly with needle like feathers. Head white, three lines on the throat and neck were developing from brown patches, a few brown patches on flanks at the base of things, legs whitish feathered; feet yellow and claws black. There were two blackish prickles, one on each side of the red tongue 1 cm short of the tip, pointed inwards may be so the prey could be easily taken but prevented from slipping out. A white powdery material was present at the base of the bill. On close approach it reacted with open gape and outstretched wings. It could now swallow lizards whole (head first) and other small prey.

On 3.6. 91, when the chick was 30 days old, it was overall brown. Base of the bill and forehead whitish, breast rufous brown with dark brown streaks; eyes dark brown, legs yellow. Tail and outer feathers of wings were fully developed to full length yet. Underwings were whitish with dark brown spots. Distinct white patch of the nape and slight white on flanks was already visible.

On 10. 6.91 the chick almost resembled an adult. The first flight was not observed and the fledging period was approx. 40 to 45 days. Around this time the temperature recorded at Pugal (30 km west of the nest) was an unbelievable 56°C. On 11.6.91, in the morning, the chick was seen dead on the sandy ground below the nest. There were no apparent injures and the death could have been caused by heat stress.

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8. COOT FEEDING ON WATER HYACINTH

Water Hyacinth (*Eichhornia crassipes*) is a very troublesome aquatic weed. This free floating plant with beautiful violet flowers and a conspicuous floating organ is commonly encountered at most freshwater bodies in India in the form of thick mats. Not much is known about the interactions of the plant with aquatic birds. However, I have observed that some species of waterfowl - mainly Coot (*Fulica atra*) and to a minor extent Gadwall (*Anas strepera*), Shoveller (*A. clypeata*) and Mallard (*A. platyrhynchos*) graze upon hyacinth. The consumed portions of the plant are leaf and the bulbous floating organ. These observations were made at Okhla Barrage, on River Yamuna near Delhi during the winter of 1989-90 and also 1990-91.

According to Ali and Ripley (1983) Coots chiefly consume vegetable matter, i.e. shoots and seeds of aquatic plants and also, sometimes, small fish and invertebrates. At Okhla Barrage Coots were observed plucking rooted vegetation in the middle of the reservoir and foraging at exposed mudflats during low water. However, during January - February each year, more Coots were observed feeding on hyacinth, resulting in extensively cropped mats.

I have not observed water hyacinth being consumed by Coot or other waterfowl elsewhere, nor have heard of reports confirming these observations. According to Gopal and Sharma (1981) water hyacinth has low digestible nutrient content and high water content (~ 90%). This means that a grazing Coot has to spend more time and energy consuming large quantities of low value food (and possibly spending more energy in the excretion of excess water). However, the advantage to Coot may be that since water hyacinth is locally abundant less energy need be expended in food location or capture.

The distribution pattern of Coot and water hyacinth at Okhla is noteworthy. Numerically

TABLE 1

ABUNDANCE OF SOME WINTERING WATERFOWL SPECIES AT DIFFERENT SITES ON OKHLA BARRAGE BASED ON COUNTS DURING FEBRUARY, 1991

Waterfowl	Sites				Total	%age
	I	II	III	IV		
Coot	125	800	100	100	1125	74.06
Wigeon	0	0	5	50	55	3.62
Shoveller	7	15	70	100	192	12.62
Pintail	0	10	15	25	50	3.29
Spotbill	30	5	10	0	45	2.96
Brahminy Duck	15	25	0	0	40	2.63
Mallard	0	0	2	10	12	0.78

speaking, coot is the most abundant waterfowl species in winter at Okhla. The reasons for this are not very clear yet but it is easily confirmed by studying their proportion in Waterfowl counts from several randomly chosen sites on the barrage (Table1). Similarly, on the basis of visual estimates water hyacinth appears to be the dominant vegetation in terms of biomass at Okhla. A large amount of hyacinth is brought in by the flow of the river which gets clogged at the gates of the barrage besides the one which propagates by flowering or vegetatively in the still areas of the reservoir.

ACKNOWLEDGEMENT

I acknowledge a research associateship awarded by CSIR, Delhi.

February 1, 1992 **ABDUL J. URFI**

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9. RECOVERY OF RUSSIAN RINGED GREY PLOVER (*PLUVIALIS SQUATAROLA*) AT POINT CALIMERE

The grey plover *Pluvialis squatarola* breeds on the Arctic tundra of Europe and Asia from the Kanin Peninsula to East Siberia, and in Arctic North America, and migrates south through Europe and Asia to winter quarters in Africa, Madagascar, India, Burma, Malaya and Thailand (Ali & Ripley 1983). It is almost cosmopolitan in distribution as its winter range extends to coasts of South America, Africa, southern Asia and Australia. But it is not known whether there are any migratory divides between birds migrating south-west to Europe, or south to south-east to Asia and Australia (Cramp and Simmons 1983).

The bird migration study carried out under the Bird Migration Project of the Bombay Natural History Society confirmed the species as a regular winter visitor to India in hundreds. At Point Calimere (10° 18' N; 75° 51'E) an adult grey plover with a Russian Ring was recovered on 14th January 1990 in the presence of Russian ornithologist Prof. E.I. Gavrilov. Later we were informed that the bird was ringed by him at Taldy Kourgansky (46° 41' N; 80° 36' E) on 6th August 1989. As this species is known to breed in the high Arctic region, it is evident that the occurrence of this bird at the place of ringing in August was on its autumn passage to the wintering ground in south India. It is possible that the bird has taken the straight route towards south as the places of ringing and recovery fall almost in a straight line.

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10. OCCURRENCE OF THE KNOT *(CALIDRIS CANUTUS)* IN ANDHRA PRADESH

While carrying out studies on bird migration at Pulicat bird Sanctuary (13° 25'-13° 55' N, 80° 03'-80° 19' E) in south coastal Andhra Pradesh, a solitary knot was trapped and ringed from the coastal mudflats of the sanctuary on 21.12.1990. The similar looking Eastern knot (*Calidris tenuirostris)* also recorded from Pulicat (Mohapatra and Rao, *JBNHS* in press) has a longer bill and tarsus and dark brown upper tail coverts as compared to the knot.

MESUREMENTS OF KNOT AND EASTERN KNOT (IN MM)

Species	Wing	Bill	Tarsus	Tail	Weight	Banding date
1						
.*C.canutus** (Knot)	153	31.5	30	53	91	21.12.90
C. tenuirostris # (Eastern Knot)	181	41.5	36	63	133	19.09.90

* BNHS Ring AB-129515. # BNHS Ring B-57777.

It appears that the knot is not so scarce as it was once thought to be. A few in recent years are annually found in Manner as also south SriLanka (Hoffman *JBNHS* 86: 10. 1989).

However recently a few individuals of Knot (17) and Eastern Knot (13) were ringed from Mandapam in Tamil Nadu by the BNHS Bird Migration Project. Prior to this there have been no records of the knot from Andhra Pradesh coasts, hence it is interesting to place its occurrence on record.

May 29, 1992

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11. COMMON GULL *LARUS CANUS* LINNAEUS RECORDED IN INDIA

On 19 January 1992, P.A. Dan Zetterström, Göran Ekström and others observed a first -winter Common Gull *Larus canus* at Yamuna river, Delhi. This constitutes the first record from India.

The Common Gull was found roosting in a little pool together with a few Brownheaded Gulls *L.brunnicephalus* and several Blackheaded Gulls *L. ridibundus.* It was watched for about 5-10 minutes from a distance of *c.* 100 metres through telescopes with 20 x magnification. At one point the whole flock took off, and the Common Gull could be seen well in flight, before it settled again. Unfortunately, no photographs could be taken.

Description and identification: The Common Gull was somewhat larger and heavier than Brownheaded Gull. The bill was pale greyish pink with a black tip. The head, neck and underparts were white with some sparse brownish mottling, mainly on the neck and sides of breast. The mantle and scapulars were medium grey. The lesser and median coverts were brown with diffuse paler fringes, and the greater coverts were pale grey-brown. The tertials were dark brown with pale edges and tips. The folded primaries were blackish. In flight it showed blackish primary coverts, outer primaries and secondaries, contrasting with paler inner primaries and paler upper wing coverts.The under wing coverts and axillaries were mainly whitish with some dark feather-tips, forming dark bars. The rump, upper tail - coverts and tail were white, the latter with a clearcut, rather broad blackish band. The legs/feet were pale pinkish, and the iris was dark.

The common Gull was easily distinguished from the Brownheaded - and Black headed Gulls it associated with by, e.g. the larger size, darker grey mantle/scapulars, lack of a dark ear covert spot, the dark mottling to the head, neck and underparts, the less reddish tinged bill and legs/feet, and in flight by the all dark outer primaries and primary - coverts and mottled underwing-coverts axillaries. It was easily separated from first-winter Great Black headed Gull *Larus ichthyaetus* by the much smaller size of body and bill and the lack of a dark ear covert patch. From second winter Herring Gull *Larus argentatus* it differed in considerably smaller-sized body and bill, less variegated pattern to the upper wing - coverts (including rather uniformly grey - brown greater coverts; these are strongly mottled in Herring Gull), whiter and less mottled under wing - coverts and whiter rump, upper - tail coverts and tail with narrower and more clearcut terminal band.

It seems likely that the Common Gull was of the subspecies *heinei* as that is the one breeding nearest to India (breeding in Western and central Siberia, wintering around Black and Caspian sea, Iraq and Persian Gulf). On plumage, first-winter *heinei* is not distinguishable from the nominate subspecies. The subspecies *kamtschatschensis* (breeding in north-east Siberia, wintering in coastal eastern Asia) and *brachyrhynchus* (north - west North America) can be eliminated, as these show more heavily mottled head, neck, underparts underwings, rump and upper tail- coverts and broader tail-bands.

Status in the Indian Subcontinent:

J.S. Serrao (*in litt.*) has kindly informed me that this was the first record from India, although he mentions five previous records for the Indian Subcontinent: in Nepal a first-winter bird at Kosi Barrage on 12-21 January 1974 (Inskipp & Inskipp 1984) and an adult at Phewa Tal, near Pokhara on 21 January 1981 (Redman, Lambert and Grimmet 1984), and in Pakistan one (age?) in the Punjab area on 27 January 1974, one (age?) at Rasul Barrage on 27 January 1974, and one(age?) at Rawal Lake, near Islamabad on 17 November 1974 (Redman, Lambert and Girmmet 1984).

ACKNOWLEDGEMENTS

I am most grateful to J.S. Serrao for supplying information on the status of Common Gull in the Indian Subcontinent

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12. FURTHER EVIDENCE ON THE OCCURRENCE OF THE BLACK TERN *CHLIDONIAS NIGER* (LINNAEUS) ON INDIA'S EASTERN COAST

On the 12th October 1990, while banding aquatic birds at Pulicat Bird Sanctuary southern Andhra Pradesh we ringed a solitary Black Tern (*Chlidonias niger*) along with fifteen Whiskered terns (*Chlidonias hybrida*). The Black Tern was identified from the other similar terns (Whiskered and Whitewinged Black Tern) on the basis of a dark mark on either side of the neck in front of the base of the wings. The bird had the following measurements:

Wing (mm)	Bill (mm)	Tarsus (mm)	Tail (mm)	Weight (gm)
202	28.5	17	75	51

The Black Tern has been rarely reported from the Indian Subcontinent (Alexander *JBNHS* 49: 120-121. 1950). However in the recent past there have been two records of the species from Point Calimere in Tamil Nadu (Abdulali and Ambedkar, ibid. 80: 640. 1983, Natarajan and Balasubramanian, ibid. 87: 451-52. 1990).

From the available information and the present ring record it may seem that the Black Tern is an uncommon but regular winter migrant to the eastern coast of India. Due to its similarity with other terns, it is quite possible that the species may be overlooked amongst vast congregation of terns. Further records of the species may give a clear indication of its wintering status in India. The current record is also an addition to the birds of Andhra Pradesh (Taher and Pittie, Checklist of birds of Andhra Pradesh 1989).

May 29, 1992

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13. EXTENSION OF RANGE OF THE INDIAN SKIMMER, *RYNCHOPS ALBICOLLIS* SWAINSON (AVES: LARIDAE)

During the study of a collection of avifauna from Rajasthan, we came across a specimen of Indian Skimmer, *Rynchops albicollis* Swainson which was collected from Jodhpur district, Rajasthan. The particulars of the specimen are as follows:

Material: 1 male, Tank in Dangiwas village, Jodhpur district, coll. R. N. Bhargava, August 10, 1966.

Measurements (in mm): 1 male: Wing 326, tail 97, bill (upper) 60 and (lower) 75.

This species mainly occurs in large rivers in Pakistan, northern India, the southern limit being 16°N. latitude and east to Vietnam (HANDBOOK BIRDS 3: 75). It is rare in estuaries, inshore coastal waters and in freshwater tanks and is a vagrant when found. Butler (Stray Feathers 5: 225. 1876) recorded it from Mount Abu, a hilly area in Rajasthan about a century back. The present specimen was collected from a freshwater tank in Jodhpur, a semi-arid area in Rajasthan, about 200 km north of Mount Abu.

July 10, 1992

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14. THE INDIAN CUCKOO (*CUCULUS MICROPTERUS MICROPTERUS* GOULD) IN SARISKA TIGER RESERVE, RAJASTHAN

On the morning of 20th June 1989 in Sariska Tiger Reserve, Rajasthan, as I was walking on a transect for bird community studies near Kundli road I heard a bird call which is very familiar around Dehradun. The bird was seen on an *Anogeissus pendula* giving characteristic call of the Indian cuckoo (*Cuculus micropterus micropterus* Gould). It was dark grey above with a brownish tinge, pale ashy and white below, cross-barred with widely spaced broad black bands and also a broad, black subterminal band on tail. The round and quick flapping wings were all unmistakable. Later, on two more occasions, the bird was heard calling during July 1989. This bird may be a rare straggler and it was not seen or heard during my stay at Sariska in 1988 and 1990.

February 28, 1992 K. SANKAR

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15. BIRD HITS IN PONDICHERRY

During the last three years we noticed three birds getting killed and another getting injured apparently as a result of hitting the white washed wall of building while in flight over Gorimedu in Pondicherry. These accidents took place during September - October, 1989 - 1991.

The first victim, an Indian Pitta, *Pitta brachyura* was found lying dead in front of our house at 5.30 a.m. The second, also an Indian Pitta was found at 6 a.m. very near to the spot where the first one was found. This bird was alive but was not able to fly. When approached it hopped away and hid among the bushes of the garden. The bird was in distress but went about hopping and feeding on the ground for a few days after which it disappeared. The third victim was a brown bird, slightly larger than the Indian Pitta. It was found dead at about 6 a.m. about 3 metres away from the spot where the two previous Indian Pittas were found. This bird could not be identified. The latest instance was on 12 October 1991 when a third Indian Pitta was found dead at 6 a.m. near the spot where the first one was found.

The body of the first Indian Pita was warm to touch when found and the wings and legs of all the three dead birds were easily movable. The necks of all the three dead birds tended to droop. There was no visible external injury on any of the birds.

The Indian Pittas were found near the centre of a block of buildings having 8 flats on ground and first floors. The 7.5 m tall block is constructed facing south-east on the slope of Gorimedu, a hill about 33 m above mean sea level, located 5 km west of the bay of Bengal. From Gorimedu the ground sloped steeply down towards the bay allowing an unobstructed panoramic view towards the bay from the top of the building. The circumstances under which the birds were found suggest that they might have accidentally hit the building while flying from south-east to north-west in the predawn darkness.

According to Ali and Ripley (1983, HANDBOOK Compact edition) the Indian Pitta is a passage migrant in peninsular India, making its way towards north in May-June and in the opposite direction towards Sri Lanka in September-October. The place where the dead and injured birds were found suggest that they might have been flying in a north-westerly direction at the time of the accidents. In the absence of detailed information on the seasonal migratory pattern of the Indian Pitta it is not possible to fully understand the significance of these occurrences at present.

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16. PLAYING WITH FIRE ? ALPINE CHOUGHS PLAY WITH A TIBETAN RED FOX

Play behavior has been defined as "all postnatal motor activity that appears purposeless, in which motor patterns from other contexts may often be used in modified forms and altered temporal sequencing" (Bekoff and Byers 1981, p. 300). Some behaviors that initially appear to have an immediate function, may upon further reflection, appear not so. Such behaviors may be play. In this note, we describe an observation that we interpreted to be interspecific play in Alpine Choughs (*Pyrrhocorax graculus*).

Between 06:21 and 06: 22 h on 22 July 1992, M.F. observed 5 or 6 Alpine Choughs circling around and diving in turn at a Tibetan Red Fox (*Vulpes vulpes montana*) in Dhee Sar (36° 81'N, 74° 95' E), Khunjerab National Park, Pakistan. Dhee Sar is a relatively flat hanging alpine meadow (elevation 4,100-4,300 m) bordered by steep ridges on two sides and glaciated peaks on the upper side. A medial ridge bisects the upper portion of the meadow. The choughs and fox were observed from this ridge using 7 x 35 binoculars and a 15-45 power spotting scope. This lookout gave an unobstructed view of the interaction that took place less than 450 m away. The fox was viewed for 10 min prior to the onset of the interaction.

Several or all of the choughs took turns diving to within 1-2 m of the fox while the others swarmed 3-4 m overhead. No vocalizations were heard to accompany this behavior, but a loud glacial stream flowed between the observer and the location of the incident. When the diving began, the fox immediately ceased walking and either sidestepped or , more commonly, crouched as each chough made its pass. This interaction ended when the choughs flew away after approximately 1 minute, and the fox appeared to continue along its way. No direct contact between the choughs and the fox was observed. Chough (*Pyrrhocorax* spp.) feathers have previously been identified in fox scats collected at Dhee Sar (Blumstein and Robertson, ms).

We identified at least three mutually exclusive interpretations for this observation.

First, the choughs could have been foraging. Tibetan red foxes have been observed carrying prey in their mouths on 5 other occasions and eating at a large carcass on 4 different occasions. (Only two days before, another fox was observed in the same general area carrying a dead marmot). Choughs have been observed scavenging at fox kill sites. Other birds-Bald Eagles (reviewed in Bent 1937), and Ravens (Bent 1946) are known to attack terrestrial predators with prey. The predator may consequently abandon its prey which is then scavenged by the birds. However, we reject this foraging hypothesis as an explanation for the fox-chough interaction; at the time of the attack, the fox was carrying no food.

Second, the Alpine Choughs could have been mobbing the fox to defend nestsites and/or nestlings, or foraging areas. We will address each of these in turn.

Alpine Choughs are sometimes reported to nest in colonies, and nest sites are primarily located in cracks and niches of cliffs (Roberts 1992). In four summers of work throughout Dhee Sar, no nest sites were ever located. In late July, juvenile choughs appeared adult- sized and foraged in mixed flocks with adults. Furthermore, they appeared quite manouvrable-engaging in what appeared to be intraspecific locomotor play. Also, despite our extensive movements throughout the meadow, no Dhee Sar "Resident" (3-5 researchers / assistants) has ever been swarmed and /or dived at by choughs. Thus we reject the nest and/or nestling defense hypothesis on three counts: no colonial nesting site was located within at least 1 km of the interaction site, the nearest potential nest sites (cliffs) were over 100 m away, and fledglings appeared to be as capable as adults in escaping predators.

However, the choughs could have been attempting to discourage the fox from frequenting chough foraging areas (Curio's 1978 "moving on hypothesis"). Foxes have been observed 45 times over 387 days of research at Dhee Sar and Alpine Choughs are seen daily. Yet, never before has anyone seen choughs interact with foxes.

Since "mobbing" is assumed to be risky (Curio and Regelmann 1986), foraging sites should only be defended when there are clear and substantial benefits from mobbing. However, we observed choughs foraging throughout the meadow. The height of the vegetation where the choughs dove at the fox was low and was not significantly different than other locations in the meadow ($T = 0.5857$, $P > 0.5$, $df = 18$). Nor were there obvious depressions or boulders nearby where a fox could hide. In fact, the location was somewhat remarkable for it afforded excellent visibility for a chough-sized bird on the ground. Unfortunately, our sightings of foxes were infrequent enough to prevent a rigorous test of the hypothesis that mobbing discourages foxes from returning to the same location. However, even if we could have tested this hypothesis, there are other reasons why a fox might not return to the same location in subsequent days. For instance, while the fox was interacting with the choughs, golden marmots (*Marmota caudata aurea*) from at least 6 surrounding groups were aware of the fox, while marmots from 3 of these groups alarm called at the fox. Signals may discourage a predator from hunting in a particular area (sensu Hasson 1991). Since we can identify no specific immediate benefits from diving at the fox, we reject the mobbing hypothesis in both forms.

Third, the choughs could have been playing. We have not been able to reject this hypothesis. Furthermore, several observations support this as a probable explanation of the observed behavior. First, play behavior is most common in gregarious species, and other forms of play have been reported in Alpine Choughs (Ali and Ripley 1987). Avian play is most common in altricial species (Ortega and Bekoff 1987), and choughs are altricial. Play between birds and potential mammalian predators has been reported between Ravens and wolves (Mech 1970). Second, the observed swarming and diving resembles the mobbing behavior often used as a predator deterrent in nesting colonies; it may have been "practice" mobbing, which falls under Bekoff and Byers' (1981) definition of play (i.e. , "motor patterns from other contexts", p. 300). Third, Alpine Choughs appear to commonly take risks by approaching humans (Fleming *et al.* 1984, unpubl. obs.), and may perhaps more readily incur the potential costs of play with hetero-specifics. Future benefits (e.g. improved defense of nests or young, or increased abilities to scavenge prey) may outweigh the immediate costs, if any, of playing with a potential predator.

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March 30, 1993

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17. SOME NOTES ON THE HABITS AND HABITATS OF WHITECAPPED REDSTART *CHAIMARRORNIS LEUCOCEPHALUS* (VIGORS)

Whitecapped Redstart or River Chat *Chaimarrornis leucocephalus* (Vigors) is one of the commonest Chats found along the rivers and streams of hilly areas of Himachal Pradesh. During the last ten years from 1981, the species has been observed by me in the NW Himalayan states of Jammu & Kashmir, Himachal Pradesh, Western Uttar Pradesh and Punjab. According to Salim Ali and Ripley (1973), this species is a common altitudinal migrant in the Himalayas. The birds start arriving in their

TABLE

S.No.	Area	Altitude	Period of obsercvation	Remarks
1.	Dachigam National Park (J & K)	1650 m	20.4.81 to 27.4.81	Observed regularly during this period.
2.	Overa Sanctuary, Dist. Anantnag (J & K)	2150 m 2.5.81	28.4.81 to	Birds seen and heard along the river Overa.
3.	Mandi (H.P.)	850 m	3.10.85 to 4.10.85	Commonly seen along the river Beas.
4.	Bathar in Great Himalayan National Park, Dist. Kullu (H.P).	1800 m	7.10.85	Few birds seen along a mountain stream.
5.	Harike Lake Sanctuary, Dist. Amritsar (Punjab)	300 m	27.11.85 to 29.11.85 5.12.85	Single bird seen on close to Harike barrage.
6.	Mandi (H.P.)	850. m	16.4.86 to 22.4.86	Commonly seen along the river Beas.
7.	F.R.I. Campus, DehraDun (U.P.)	600 m	25.10.86	Birds seen and heard along the canals flowing through F.R.I. campus.
8.	Kugti Sanctuary, Dist. Chamba (H.P.)	2350 m	14.9.87 to 16.9.87	Commonly seen along the Budhal Nala near Kugti.
9.	Pong Dam Sanctuary, Dist. Kangra (H.P.)	350 m	7.12.87	Birds seen and heard along the lake.
10.	Sangla Valley, Dist. Kinnaur (H.P.)	3100 m	19.5.88	Common along the river Baspa at Sangla.
11.	Solan (H.P.)	1500 m	3.10.88 to 29.10.88	Heard and seen almost daily during this period.
12.	Chansil Pass, Dist. Simla (H.P.)	3650 m	26.5.89	Single bird seen during fifteen minute halt.
13.	Solan (H.P.)	1500 m	31. 3.90 to 30.4.90	Heard and seen almost daily during this period.

winter habitat in October and are mostly gone by the end of April as is evident from the Table .

During the surveys undertaken in the Mandi and Kullu areas of Himachal Pradesh, it was found that while the earliest arrivals have descended to an altitude of 850 m, the last of the species were still at an altitude of 1800 m (Table , S. No. 3 & 4). It can be concluded from the above observations that, weather remaining normal, these birds migrate gradually and there is no sudden exodus from a particular area. This fact is supported by the observations made by me in the environs of Solan since 1988. The city is located at an altitude of 1500 m in Himachal Pradesh. These birds start descending through Solan during the first half of October. During the year 1988, the first arrival was observed on 3.10.1988, whereas the last of the species was seen on 29.10.1988 (Table , S. No. 11). The daily temperature during this period fluctuated between 10.5° C to 24°C. The birds start ascending again in the last week of March and early April. During the year 1990, the birds were observed ascending between the period 31.3.90 to 30.4.90 (Table, S.No. 13). The temperature variation during this period was almost the same as while the birds were descending.

During my observations on this species at Solan, the birds, always singly, were seen feeding on ground in the backyard of a residential building pursuing insects. Very often, a bird was found sitting on the roof of the building, giving its shrill call announcing its presence in the locality. Occasionally the bird would peep into a half built house through the window but never enter it.

This species has been described as a strictly water-bird dwelling on the banks rivers and mountain streams particularly in forested areas (Salim Ali and Ripley 1973, Whistler 1928). At Solan, however, there is no running stream within one km radius of the locality where these observations were made. The vegetation of the locality is dominated by *Prunus* sp. followed by *Pinus roxburghii* and *Toona ciliata*. Three species of shrubs, namely *Debregeasia* sp., *Rosa maschata* and *Berberis* sp. are also common in the area.

January 6, 1992 M.L. NARANG

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18. KEELED BOX TURTLE IN KARBI ANGLONG — A NEW LOCALITY RECORD

The Keeled Box Turtle (*Pyxidea mouhotii*) is a small chelonian with a moderately elevated and flat-topped carapace. There are three conspicuous keels on its shell. The posterior marginals are serrated. Heavily scaled limbs, which are dark grey in colour are yet another notable feature. Its upper jaw is hooked. the colour of the carapace is light yellowish-brown. Top of head grey with maroon blotches. Iris orange, pupil of the eye black.

In India, this turtle has been recorded in Tirap district of Arunachal Pradesh, North Cachar Hills district of Assam, and Garo Hills of Meghalaya. Outside, it extends upto Vietnam (Das 1985, Indian Turtles: A Field Guide. WWF-India.).

On 22nd May, 1992, a local Karbi (tribal) shikari gave me a live turtle caught in the forests of Dhansiri RF of Karbi Anglong district in Central Assam (25° 40' N , 96° 20'E). I kept the reptile for a week at the circuit House, Diphu. During captivity it relished cockroaches. Then on 28th May, 1992, I released it back in to Dhansiri RF.

It measured: carapace length 14.5 cm; carapace width 11 cm. The habitat where it was caught in low hill forests with tropical semi-evergreen vegetation, altitude of the place was about 200-250 m above mean sea level.

January 2, 1993 ANWARUDDIN CHOUDHURY

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19. FIRST RECORD OF *CYRTODACTYLUS FASCIOLATUS* (BLYTH), THE BENT-TOED BANDED GECKO (SAURIA: GEKKONIDAE: GEKKONINAE) FROM GARHWAL HILLS

Cyrtodactylus fasciolatus (Blyth), the Bent-toed banded Gecko has so far been recorded from Shimla hills (Subathu) and Kumaon hills (Almora, *c.* 1,615 m) (Blyth 1860, Annandale 1914,Smith 1935). Recently, we collected a beautiful specimen (17.2 cm in total length) of the species from the crevices of a road side stone wall near Ghansali along Tilwara road, District Tehri-Garhwal (*c.*950 m, coll. Akhlaq Husain and Pranjalendu Ray) on the night of 25th May, 1992. The lizard, being nocturnal came out to feed on insects and two specimens were collected. One escaped. Earlier, another specimen (16.4 cm in total length) was collected from the vicinity of village Damdeval, District Pauri-Garhwal (*c.* 1,850 m, 24. iv. 1989, coll. Arun Kumar) during a survey of the area.

The present find from Garhwal hills is interesting from a zoogeographical point of view as it completes the interrupted range of its distribution, at least in one stretch of Western Himalaya. The species is apparently endemic in the Western Himalaya at low and moderate elevations, as pointed out by Annandale (1914).

All the specimens, were males as determined by the presence of paired postanal bones lying on each side of the base of the tail just behind the vent and the pores on all femoral scales (17-18 on each side). The preanal scales (6-7) are without pores. It is worth mentioning that according to Annandale (1914) the males are without femoral pores and with 10-12 preanal pores whereas Smith (1935) was not sure of the presence of preanal and femoral pores in males as he could examine only female specimens.

The present material agrees in general with the description of the species by earlier workers (op. cit.) except for the following variations:

1. Diameter of ear-opening 3.0 - 3.3, 3 times in diameter of eye (*vs.* about half of the eye, Smith 1935).
2. Scales across the mid-belly between lateral folds 26 in Tehri specimen (*vs.* 28 -34, Smith 1935).
3. Femoral scales 17-18 on each side (*vs.* 15-16, Smith 1935), all with pores (*vs.* no femoral pores in males, Annandale 1914).
4. Males with a row of 6 -7 enlarged preanal scales behind femorals, without pores (*vs.* male with 10-12 preanal pores, Annandale 1914).

Besides, the following observations hitherto unrecorded, have been made:

1. Edge of eye-lid with two rows of backwardly directed pointed tubercles, arranged alternately.
2. Cone-shaped enlarged tubercles on anterior one-third of tail, arranged in transverse rows.
3. Four parallel ridges running longitudinally on middorsal of body and two such ridges on tail (more prominent in Tehri specimen).
4. Scales on ventral and ventro-lateral sides of body dotted with black.

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April 24, 1993

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20. PRESENCE OF SANDFISH *OPHIOMORUS TRIDACTYLUS* (BLYTH) IN EASTERN RAJASTHAN

The Sandfish *Ophiomorus tridactylus* (Blyth) is a weak-legged lizard that lives just below the surface of sand dunes. It occurs in Punjab, Kutch, Sind, Afghanistan, Baluchistan and Persia (Smith 1935). According to Daniel (1983) it is peculiar to the sandy tracts of north-western Rajasthan and Pakistan.

Observations in 1984 revealed that it is very common within and around the Desert National Park, Jaisalmer. To locate this species outside the desert region, eastern and southern Rajasthan were widely surveyed.

In March 1992, the characteristic trails of sandfish were observed in the approximately 2 ha area near Jawahar Nagar Forest Officers' Residential Colony on the eastern outskirts of Jaipur city. It is a moderately sandy locality and presently clad with a *Acacia tortilis* plantation, raised in 1986.

In August 1992, an area approximately 10 m^2 was dug up and three individuals of this species were captured. After identification all of them were released in the same locality. This may be the first record of this species in the eastern part of Rajasthan, far away from the Thar Desert.

Twenty years back the whole surrounding area had no biotic interference due to human settlement. But in recent years, the area has been badly affected by unplanned human settlement putting the sandfish population under threat.

February 27, 1993 SATISH KUMAR SHARMA

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21. NEST - DESERTION BY A KING COBRA (*OPHIOPHAGUS HANNAH*)

On 23 May 1992, a tribesman lead me to a deserted nest of a King Cobra in a dense bamboo jungle near Top Slip in the Indira Gandhi Wildlife Sanctuary, Anaimalai hills (altitude *c.* 740 m). The man told me that a couple of months earlier several village people had seen the parent snake guarding the nest. He said that the snake would slither away towards some nearby holes everytime someone approached and showed no signs of aggression.

The nest was a mound of bamboo leaves at the base of a bamboo thicket. After making sure the nest was deserted, I carefully shifted aside the tightly packed dry leaves down to a depth of about 30 cm until I reached the decaying humus layer. Amongst the dark coloured moist humus lay 10 decomposed eggs. The clutch was in a bowl shaped circular depression about 30 cm in diameter, apparently made by the parent. The entire area was swarming with small black ants with their tiny white eggs, and one of the snake eggs had a maggot on it.

The eggs were leathery, dirty-white and greatly wrinkled. Three of the eggs averaged 67 x 37 mm in dimension. (We could not measure all the eggs due to the threat of elephants in the vicinity). When we returned to the site the very next day for taking photographs, all but two of the eggs had been eaten by some animal. Fragments of the eggs were strewn about the area.

The nest was placed within 15 m of a water-hole created by a check dam. This pool is visited regularly by local people for fishing and washing, and this disturbance probably led to the nest desertion.

King Cobras are quite familiar to many of the tribals living around Top Slip. A few years ago an adult measuring "about 5 m" was run over by a lorry on the Parambikulam road about a kilometre from Top Slip. The specimen was skinned by the Forest Department and the exhibit remained in custody of the Department for some time. More recently, I picked up a 68 cm-long dead King Cobra from inside the evergreen forests of Karian Shola National Park near Top Slip. The reptile had been apparently trampled to death by some animal.

January 2, 1993 R. KANNAN

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22. RANGE EXTENSION OF THE BOMBAY SHIELD-TAIL SNAKE *UROPELTIS MACROLEPIS* (PETERS 1861) (SERPENTES: UROPELTIDAE)

On 20 October 1992, one of us (MRA) collected a dead specimen of a Uropeltid snake along the roadside, in the evergreen forests of Amboli hills (15° 52'N, 73° 56'E) (1158 m msl) in Savantvadi taluk, Sindhudurg district, Maharashtra.

The specimen, which was fresh and in good condition, was identified in BNHS as the Bombay shield-tail snake *Uropeltis macrolepis*. The specimen measured 332 mm in total length, which is more than the 300 mm described by Smith (1943), and 12.76 mm in diameter. The morphological characters are as follows: body cylindrical; tail end obliquely truncated above, the truncated portion slightly convex and covered with mostly bicarinate scales forming a disc. Scales smooth, in 15 rows; ventrals 124; caudals 9. The body was dark purplish-brown; a short broad, yellow stripe on the lips and sides of the neck continued as large spots on the interior part of the body.

The distribution of *Uropeltis macrolepis* has been described as Bombay hills (i.e. Matheran, Khandala, Lonavla and Igatpuri) between 18° 7' and 19° 7'N by Smith (1943). A new form of this species, *Uropeltis macrolepis mahableshwarensis*, was described by Chari (1951, 1952, 1954). This form is restricted to Mahableshwar. The BNHS collection records show that two juvenile specimens of *Uropeltis macrolepis* (Reg. No. 2729) have been collected from Koyna, Satara district. The present collection from the southern part of the state extends the range of distribution of this species southwards from 19°7' to 15° 52' N in the Western Ghats.

January 19, 1993

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23. RECORD OF THE VERRUCOSE FROG *RANA KERALENSIS* (DUBOIS) IN SHOOLPANESHWAR WILDLIFE SANCTUARY (BHARUCH DIST.,GUJARAT)

Shoolpaneshwar wildlife sanctuary is a part of Rajpipla forest and situated on the left bank of Narmada river. The area is hilly and is located between 73° 32' & 73° 54' E and 21° 34' & 21° 32' N. During the faunal survey of this area we collected three frogs which were identified as *Rana keralensis* (Dubois) on account of the following characters: Warty dorsal surface with several glandular folds; smooth ventral surface. Moderately large head with an obtusely pointed snout projecting slightly beyond the mouth. Toes 3/4 webbed; two phalanges of the 4th toe free; outer metatarsals separated by web nearly to the base. Tibiotarsal articulation reaches nostril. Colour: brownish black above with darker markings; limbs and lips barred. Ventrally white. These frogs were seen near the streams flowing through the forest areas of Sagai and Mosda. The finding constitutes a new record of this species in Gujarat.

Collection details: (a) Sagai, 12. x .91, (b) Mosda, 15.iii.92, by K.R. Vinod and (c) Mosda, 8.xii. 91, By Y.M. Naik.

Measurements: (a) Sagai: Snout to vent length 61 mm., front limb 32 mm; hind limb 109 mm; (b) Mosda: Snout to vent length 60 mm; front limb 32 mm; hind limb 115 mm. (c) Mosda: Snout to vent length 62 mm; front limb 31 mm; hind limb 107 mm.

The verrucose frog was first described as *Rana verrucosa* by Gunther in 1875 and renamed in 1980 as *Rana keralensis* by Dubois. This little known species is considered as endemic to the Western Ghats (Daniel 1975). However this species can no longer be considered as endemic to Kerala or Tamil Nadu as its range extends further through Karnataka up to Maharashtra (Daniels, R.J. 1992). Record of this species in the above areas of Gujarat indicates that the range of this species extends at least up to the left bank of Narmada river in Gujarat.

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August 7, 1992

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24. THE COMMON TOAD *BUFO MELANOSTICTUS* AND THE GARDEN LIZARD *CALOTES VERSICOLOR* FEEDING ON SWARMING TERMITES

Instances of animals and especially birds, capitalising on the abundance of prey during swarming of termites for the nuptial flight is well known. I report here such an instance in the case of amphibians and reptiles. On 24.iv.92 at 0930 hrs at Vedaranyam (10 km north of Point Calimere Wildlife Sanctuary, Thanjavur district, Tamil Nadu), There was a sudden summer downpour. Within five minutes of the showers, I witnessed a congregation of 23 toads *Bufo melanostictus* and 5 garden lizards *Calotes versicolor* feeding on the termites swarming out of a termite hole. What was interesting was the swiftness with which the toads gathered, and during the day.

April 24, 1993

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25. OCCURRENCE OF THE FRESHWATER GREY MULLET *RHINOMUGIL CORSULA* (HAMILTON) AT THE TUNGABHADRA - KRISHNA CONFLUENCE NEAR NANDIKOTKUR, ANDHRA PRADESH

The freshwater grey mullet *Rhinomugil corsula* is reported from the Gangetic river system (Hamilton 1822), rivers and estuaries of Bengal and Burma (Day 1889), Cauvery river system (Menon and Jayaram 1977) and Bhima river (Pradhan and Singh 1984). Pradhan and Singh (1984) presumed the recent recording of this species in the rivers of Maharashtra as due to accidental introduction along with carp fry from Calcutta by the State Fisheries Department.

On 7.xii.92, I made a trip to 'Sangameshwaram' the confluence of the River Tungabhadra (which is in fact a tributary of the Krishna river) and River Krishna near Nandikotkur (15° 52' N and 78°18' E), and found the freshwater grey mullet in great abundance there. This species is easily identified by its peculiar habit of swimming in small shoals at the water surface with its eyes protruding out of the water.

Their occurrence here is of interest, as the Bhima is a tributary of the Krishna, and poses questions whether the occurrence of this species in the Krishna river system is a result of accidental introduction, or expansion/migration of the species along the river system from areas where it existed undetected earlier.

May 7, 1993 RANJIT MANAKADAN

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26. SEXUAL DIMORPHISM OF A FRESH WATER PUFFER FISH, *TETRAODON (MONOTRETUS) TRAVANCORICUS* HORA & NAIR, COLLECTED FROM TRICHUR DISTRICT, CENTRAL KERALA

(With four text-figures)

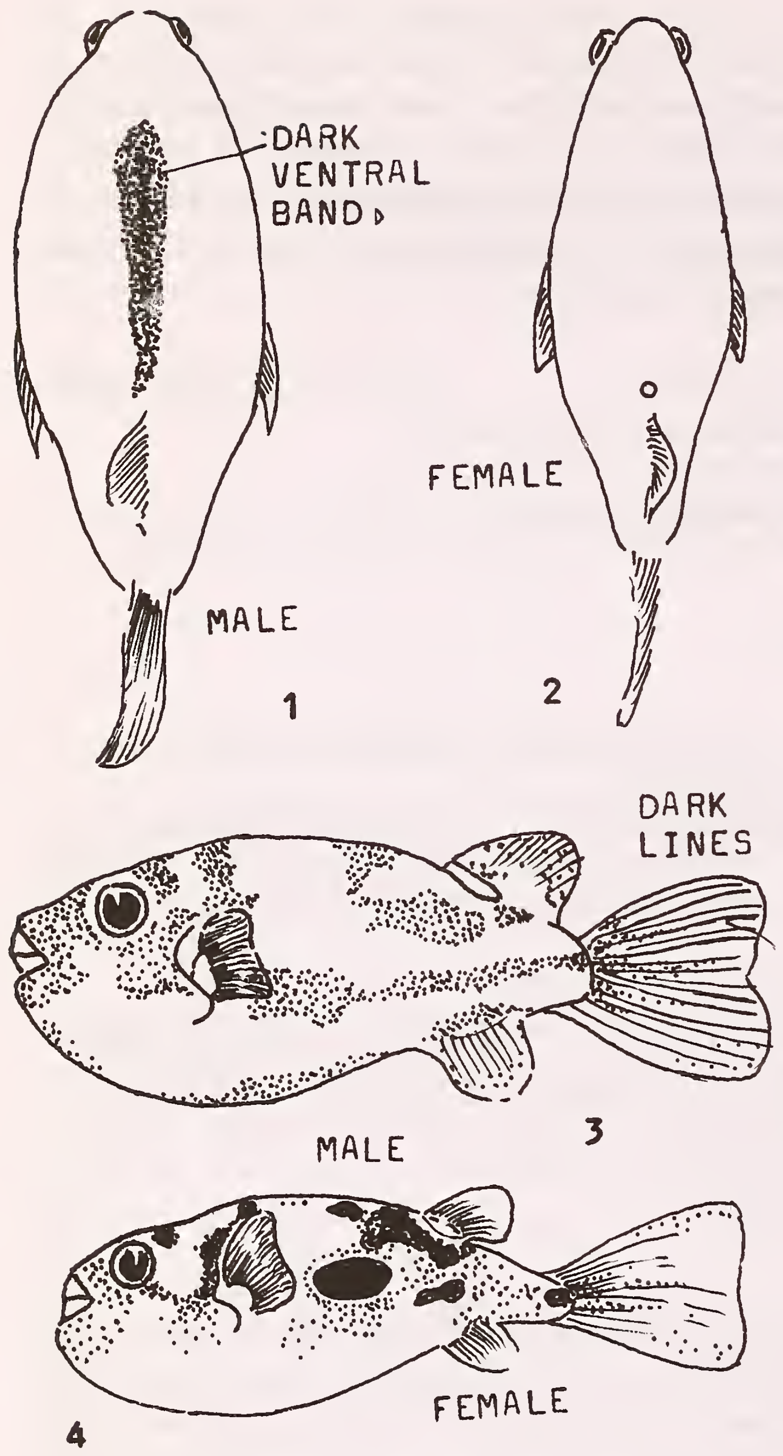
INTRODUCTION

Hora and Nair (1941, *Rec. Ind. Mus. 43*: 391-393) reported a freshwater puffer fish, *Tetraodon (Monotretus) travancoricus* from Pamba river, southern Kerala. Since then there has been no report of this species from any other locality. A good number of specimens of this species were collected by me from the inundated brickyards at Pudukkad, Trichur, Kerala. A brief description of its sexual dimorphism is given here.

SEXUAL DIMORPHISM

MALE: Males were longer and larger than females. Golden yellow in colour on the ventral side in live specimens. A dark bluish ventral band on the middle of the golden yellow, starting from the mouth and extending up to the base of the caudal fin (Fig.1). The golden yellow colour is also present at the base of the dorsal, anal and caudal fins. This colour is less prominent on the pectoral fins. Light black spots are present throughout the body (Fig. 3). The shining golden yellow on the body surface is less prominent due to the discontinuous black spots. There are a large number of narrow dark lines on the caudal fin (Fig. 3).

FEMALE: Females shorter and smaller than males. The golden yellow colour noted on the ventral



Tetraoden travancoricus Hora & Nair
Figs.1-2. Ventral view. Figs. 3-4. Entire body surface.

side of the male is absent in the female, and less prominent on the base of dorsal, anal and caudal fins. The dark bluish band noted on the ventral side of the male is replaced by a white coloured area in the female (Fig. 2). Very few dark lines are present on the caudal fin (Fig. 4), and prominent black spots on the lateral sides (Fig.4). Almost all females collected during the months of May, June and September 1990 bore eggs. The eggs within an ovary are of unequal size.

	Male	Female
1.	Body larger and longer.	Body smaller and less elongated.
2.	A dark bluish ventral band from mouth to the caudal persists even in preserved specimens.	Absence of a dark ventral band.
3.	Golden yellow colour on the ventral side.	White colour on the ventral side.
4.	Prominent golden yellow colour at the base of the dorsal, anal and caudal fins.	Golden yellow colour is less prominent at the base of dorsal anal and caudal fins.
5.	A large number of narrow dark lines on the caudal fin.	Very few dark lines on the caudal fin.
6.	Light black spots on the lateral sides.	Prominent black spots on the lateral sides.

Collection date and occurrence: The specimens were collected during the months of May, June and September 1992.

June 7, 1993 N.D. INASU

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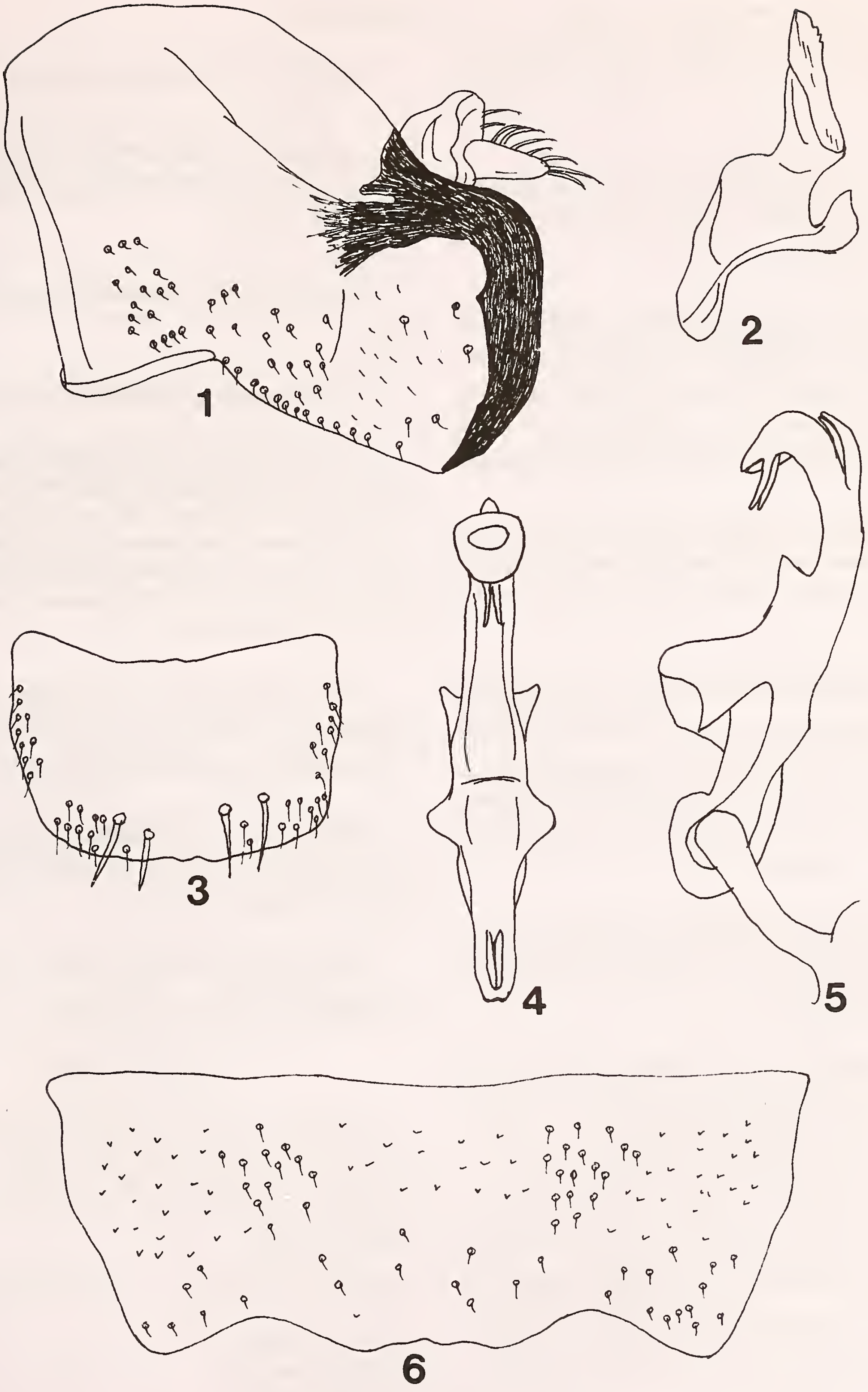
27. DESCRIPTION OF NEW RECORDS OF THE GENUS *GONIAGNATHUS* FIEBER (CICADELLIDAE: HOMOPTERA) FROM INDIA

(With six text-figures)

Goniagnathus nervosus Melichar and *G. guttulinervis* (Kirschbaum) are recorded for the first time in India. The male genitalia of *G. nervosus* is described for the first time.



Figs. 1-6. *Goniagnathus nervosus* Melichar : 1. Pygofer, lateral view ; 2. Style ; 3. Subgenital plates (fused) ; 4. Aedeagus, dorsal view; 5. Aedeagus, lateral view ; 6. Female sternum VII.

Genus *Goniagnathus* Fieber

Goniagnathus Fieber, 1866. Zool.-Bot. Gesell. Wien. Verhandl., 16: 506. Type species: *Jassus brevis* Fieber.

Goniozygum Bergroth, 1920, n.nom., invalid for *Goniagnathus* 1866. Linnavuori, 1978. Rev. Zool. afr. 92 (2): 486.

This genus was adequately described by Ribaut (1952) and Linnavuori (1978). Five species, namely *appellans, bicolor, fumosus, punctifer* and *uniformis* have been found previously in India. Two more species are recorded for the first time from India.

Goniagnathus nervosus Melichar (Figs. 1-6)

Goniagnathus nervosus Melichar, 1903. Hom. Faun. Ceylon: 180. *Goniagnathus nervosus* Melichar, Distant, 1908. Faun. Brit. Ind. Rhyn. IV: 312.

Colour: Robust yellowish-brown leafhoppers with brown dotting all over. Vertex about four times as broad as medially long, infront broadly rounded, the front margin with two reddish brown bow-shaped transverse bands. Face on sides with several black transverse irregular lines.

This species was described on the external characters only. The male genitalia is described and illustrated for the first time.

Male Genitalia: Pygofer with a pair of strongly sclerified processes from dorso-posterior margin. Macro-setae absent and only microsetae present. Valve reduced. Subgenital plates fused, short and broad, with microsetae and only a few macrosetae. Style with apophysis incrassate, Preapical lobe absent. Connective small and fused with aedeagus. Aedeagus with five short appendages, one pair from baso-lateral area, second single appendage from medio-ventral area and third paired, dorso-subapical from below the hood like apical structure; gonopore subapical.

Female VII sternum as shown in the figure.

Specimens Examined: 2 Males, 3 females, Ambalavayal, Kerala State, on Mango, 1. v. 1986, Coll. V.R. S. Rao.

Distribution: Ambalavayal, Kerala State: INDIA: SRI LANKA.

Goniagnathus guttulinervis (Kirschbaum)

Jassus guttulinervis Kirschbaum, 1868. Nassau Ver. Naturk. Jahrb. 21-22: 116. *Thamnotettix putoni* Lethierry, 1874. Pet. Nouv. Ent. 1: 444. *Goniagnathus laminatus* Ivanoff, 1885. Univ. Imp. Kharkow, Soc. des Nat. Trav. 19: 92. *Goniagnathus ocellatus* Jacobi, 1910. Schwedischen Akad. der Wiss. : 133, syn. n. *Goniagnathus guttulinervis* (Kbm.) Linnavuori, 1978. Rev. Zool. Afr. 92 (2): 493. *Goniagnathus guttulinervis* (Kbm.) Ribaut, 1952. Faune De France, 57: 190.

This species was adequately described and illustrated by Ribaut (1952) and Linnavuori (1978). It is reported here from India for the first time.

Specimens Examined: 4 Males, 8 females, New Delhi (lawn, Buddajayanti Park), 5.IV. 1987, Coll. V.R.S.Rao.

Distribution: New Delhi, INDIA: Widely distributed in different countries.

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I am thankful to Dr. (Mrs) Usha Ramakrishnan, Division of Entomology, Indian Agricultural Research Institute, for her generous help and encouragement.

November 19, 1992 V. RAMA SUBBA RAO

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28. *NEPTIS CARTICA* MOORE (LEPIDOPTERA: NYMPHALIDAE) IN THE UTTAR PRADESH HIMALAYA

Eliot (1969) notes that *Neptis cartica cartica* Moore occurs along the Himalaya, from Nepal eastwards to the Karen Hills in Burma and Tonkin. Another sub-species, *N. cartica burmana* de Niceville, occurs in south Burma and Thailand. Evans (1932) and Wynter-Blyth (1957) assign a range from Sikkim eastwards to Burma, despite the fact that Moore's Type specimens consist of a pair from Nepal (Eliot 1969). Hannyngton (in Peile 1937), in his otherwise rather comprehensive list of the butterflies of Kumaon, does not record this butterfly.

A single specimen of this butterfly (Male, FW: 3.1 cm.) was brought in by a local collector from the Sattal Valley at 1300 m. elevation in Nainital district (28°39' N, 78° 81'E) on May 16, 1986, among a series of *Neptis sankara* Kollar (Nymphalidae). No specimens came to light during subsequent years until, in the summer of 1992, local collectors were instructed to concentrate on obtaining series of *Neptini*, in the hope that this species would turn up. Two specimens were collected in the same locality on May 4, 1992 and May 5, 1992 (FW: 3 cm. and 3.2 cm. respectively)..

On the basis of the above specimens, all in my collection, the presence of this butterfly in Kumaon, Uttar Pradesh , is reported.

Little is known of its habits and early stages. Wynter-Blyth (1957) notes that it occurs at low elevation in the Sikkim-Darjeeling area. It might perhaps be more frequently met with at lower elevation in Kumaon than in Sattal.

ACKNOWLEDGEMENT

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October 7, 1992

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29. RECORD OF *DEANOLIS ALBIZONALIS* (HAMPSON) (PYRALIDAE: ODONTINAE) AS MANGO FRUIT BORER IN ANDHRA PRADESH

A pyralid mango fruit borer causing considerable damage in recent years in Godavari districts of Andhra Pradesh was identified as *Deanolis albizonalis* (Hampson) (Pyralidae: Odontinae). The borer attacked mango fruits from marble size to maturity causing serious loss. Sengupta and Behura (1955) earlier reported this as a pest of graft mango varieties from Puri in Orissa. This is the first report of *D.albizonalis* (Hampson) occurring as a major pest on mango in Andhra Pradesh.

We are grateful to the Director of Research, Andhra Pradesh Agricultural University for providing facilities to carryout the studies and to Dr. M. Shaffer, International Institute of Entomology, London for the identification of the insect.

June 8, 1993

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SENGUPTA G. C. & BEHURA, B.K. (1955): Some new records of crop pests from India. *Indian J. Ent.* *17 (2)*: 283 - 285.

30. FLOWER VISITORS AND POLLINATION OF *CAESALPINIA CORIAREA* (CAESALPINIACEAE)

Caesalpinia coriarea (Caesalpiniaceae), commonly known as Divi-Divi, is a medium sized spreading tree, with small crisp leaflets and white flowers, commonly grown in waste lands and road sides. The plants flower at Visakhapatnam (17° 42'N; 82° 78'E) in two seasons: April-July and October-November, the former is associated with hot weather season and the latter with the retreating South-west monsoon season.

The flowers are arranged in axillary clusters. The racemose inforescence is axillary and its length varies from 5-8 cm, consequently the number of flowers it bears varies from 180-302. Flowers usually mature in basipetal succession. The flowers are pedicellate. The length of each flower is [(x)0.8 cm with 0.3 cm tube]. Corolla light greenish white. Stamens 10 didynamous below the level of stigma. Anthers are small, dithecous, extrorse. Ovary sessile, few ovules are present. Style filiform, red in colour an 0.7 cm in length. Stigma terminal, bifid and light green in colour.

The flowers anthese during the period from 0300 to 0500 h. Anthers dehisce shortly after anthesis presenting the pollen. Pollen grains are small in size, spheroidal 28-35 µm in diameter, exine smooth and granular cytoplasm. Their number per flower averages 3058, of which 90% of the pollen grains are fertile. The grains are viable for 14 h from the time of anther dehiscence as indicated by fruit-set on hand-pollinations.

Nectar secretion begins with anthesis. Nectar volumes accumulated for 3 h intervals ranged from 0.01 to 0.05 µl. Sugar concentration ranges from 26-48%. Paper chromotograpy analysis revealed the presence of sugars namely glucose, fructose and sucrose, the glucose being the dominant constituent. Amino acids and proteins are also present as indicated by Nynhydrine and Bromo-phenol tests respectively. Histadine scale was recorded as 3.0.

Twenty two insect species were found foraging at the flowers during the study period (Table 1). Of these 11 are Hymenoptera (Apidae 3, 2 each of Xylocopidae, Eumenidae and Sphecidae, 1 each of Anthophoridae and Vespidae), 11 Lepidoptera (Sphingidae 1, Danaidae 1, Nymphalidae 2, Papilionidae 3, Pieridae 2 and Hesperidae 2).

Six of these 22 species foraged on pollen and nectar, and the others foraged on nectar only. All the visitors were not presented in both the years. All the insects species found at the flowers are diurnal in their activity. Most of the dominant visitors exhibited a period of peak activity. Among the bees *Apis cerana indica* was more frequent during 0600-1400 h, *Ceratina* sp. 0700-1300 h, *Bembix* sp. 0700-1600 h, *Sphex* sp. 0800-1400 h, *Delta conedus* 0800-1400 h, *Rhynchium metallicum* 0700-1500 h, *Graphium agamemnon* 0700-1400 h and *Papilio polytes* 800-1400 h.

The bees collected pollen as well as nectar. The wasps and butterflies confined their visits only to nectar foraging.

Data regarding the number of flowers visited in a minute and the time spent on a flower by common visitors indicated that *Graphium agamemnon* is more mobile covering on an average 30 flowers in a minute and spending on an average 3 seconds per flower. The corresponding figure for other species are *Papilio polytes* 20, 5; *Bembix* sp. 20, 6; *Rhynchium metallicum* 15, 6 ; *Sphex* sp. 14, 4; *Delta conedus* 20, 4; *Ropalidia spatulata* 21, 3; *Apis cerana indica* 10, 6; *Xylocopa latipes* 14, 6; and *X.pubescens* 12, 6.

The forage offered by *C.coriarea* constitutes both pollen and nectar to the flower visitors, the latter being the more predominant to wasps and butterflies. A close examination of intrafloral behaviour of the visitors revealed that wasps and butterflies made a larger number of visits compared to the bees. Pollen depletion was mostly due to foragers activity, and 60% of the pollen grains were depleted during 0700-1300 h when the foragers' activity was also found to be high.

Breeding experiments ruled-out the possibility of apomixis and autogamy. Hand-pollinations revealed that the presence of geitonogamy and xenogamy, the latter one appears to be more successful.

Pollination: Opened flowers are available during day-time from 0600 h onwards. Wasps, butterflies and bees visit the flowers during 0600-1800 h and collect nectar and/or pollen. The flowers are zygomorphic, hermaphrodite. Spontaneous autogamy does not take place because the stigma is located a little above the anthers and the contact with the anthers is unlikely. All the insects visiting the flowers are not equally effective as pollinators. The

TABLE 1

PARTICULAR OF FLOWER VISITORS ON *Caesalpinia coriarea*

Insect Visitor	Year		Forage Type	
	1989	1990	Pollen	Nectar
HYMENOPTERA				
Apidae				
Apis cerana indica	+	+	+	+
Apis florea	+	-	+	+
Trigona sp.	+	+	+	+
Anthophoridae				
Ceratina sp.	+	+	+	+
Xylocopidae				
Xylocopa latipes	+	+	+	+
Xylocopa pubescens	+	-	+	+
Eumenidae				
Rhynchium metallicum	+	+	-	+
Delta conedus	+	+	-	+
Sphecidae				
Sphex sp.	+	+	-	+
Bembix sp.	+	+	-	+
Vespidae				
Ropalidia spatulata	+	+	-	
LEPIDOPTERA				
Sphingidae				
Macroglassum gyrans	+	+	-	+
Danaidae				
Euploea core	+	+	-	-
Nymphalidae				
Hypolemnas misippus	-	+	-	+
Euthalia garuda	+	-	-	+
Papilionidae				
Atrophaneura hector	-	+	-	+
Papilio polytes romulus	+	+	-	+
Graphium agamemnon	+	+	-	+

Pieridae				
Catopsilia crocale pomona	+	-	-	+
Catopsilia pyanthe	+	+	-	+
Hesperidae				
Borbo cimara	-	+	-	+
Pelopidas mathias	+	+	-	+

bees such as *A.c. indica, A. florea, Trigona* sp., *Ceratina* sp., *Xylocopa latipes* and *X. pubescens* visited the flowers for both pollen and nectar. When they collected pollen the ventral side of the body touches the essential organs causing sternotribic pollination. The bees *A.c. indica, A. florea, Xylocopa* sp., the wasps *Bembix* sp., *Sphex* sp., *Rhynchium metallicum, Delta conedus, Ropalidia spatulata* foraged on nectar and then their back of head/thorax contacted the essential parts of the flower causing pollination through nototribically, the butterflies visited the flowers for nectar and contact of proboscis with essential organs are unlikely.

Among the 22 flower visitors the bees such as *A. c.indica, A. florea,* the wasps *Bembix* sp., *Sphex* sp., *Delta conedus, Rhynchium metallicum* and *Yopalidia spatulata* are the major pollinators, because their visits are consistent and more frequent, more mobile at the flowers and picked up more number of pollen. The remainder of species considered to be minor pollinators. Of these minor pollinators the butterflies *Graphium agamemnon* and *Papilio polytes* made substantial visits but the contact of Proboscis with the essential organs is probably unlikely.

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31. OCCURRENCE OF ERIOPHYID MITE INDUCED GALLS IN WESTERN GARHWAL

(With three text-figures)

Introduction

Plant galls are structural abnormalities accompanied by overgrowth or hyperplasy of tissues. In essence, they constitute a response of a host plant to the feeding activities of a parasite. Gall causing organisms may range from bacteria to nematodes. Among gall inducing animals or cecidozoa perhaps the eriophyid mites (Order: Acari, Superfamily: Eriophyoidea) are one of the most prolific. Ranging in length between 100 and 200 microns, these tiny acarids may give rise to a bewildering diversity of plant malformations. Eriophyid galls are usually soft and hairy and in this respect are easily distinguishable from others. Feeding by the cecidozoa is confined to the undersurface, although malformation may be more widespread. Maturity and size of the latter depend on the population size of the cecidozoa, the toxicity of the gall inducing chemicals and the extent of defensive response by the host plant. There is a high degree of specificity in the association between eriophyid and host plant. So much so that Keifer (1975) and Nalepa (1898) pioneers in eryophyid systematics have dwelt on the usefulness of gall characters to mite taxonomy. A search was made for eriophyid galls in a few localities in the western sector of Garhwal Himalayas.

Eriophyid mites obtained form this study have been kept aside for a separate investigation. In this communication, descriptions of the gall anatomy are provided. The present data would add to the information already available from the works of Mani (1973). Observations were made using a stereo-binocular microscope at 50 magnification. The host plants are in the herbaria of the Department of Biology, The Doon School, Dehradun. The altitudes of the collection localities are only approximate and given in Metres above mean sea level. The galls were collected during the month of June, 1992 by me.

1. **Quercus leucotricophora** A. Camus

Epiphyllous growth restricted to faint often slightly raised chlorotic patches; undersurface of galls with brownish hair or erineum; irregularly placed, through often more concentrated between veins; (2-3) mm in maximum width; solitary or coalesced; erineal hair easily distinguishable from normal leaf pubescence; mites found crawling, at the base of the erineum, considerably hidden from view; maximum infestation in leaves close to terminal buds.

Locality : Devalsari, altitude 2231.

2. **Juglans regia** Linn.

Soft, epiphyllous outpushings, greenish, turning brown with age; surface of convexity rugose; irregularly placed, (2-15) mm in length, oblong when mature; usually solitary, often coalesced, 5-8 galls per leaflet, appearing to spread from mid vein to outside; undersurface with wide, open ostiole and thick dense yellowish erineal hair in marked contrast to green leaf surface; older galls with brownish erinea; most trees in the locality with heavy infestation; often a second kind of gall found on leaves in the same tree, as described below.

Locality : Devalsari, altitude 2231.
Eriophyid: *Eriophyes erineus* (Nalepa)

3. **Juglans regia** Linn. (Fig.1)

Small innumerable spherical galls with smooth yellowish epiphyllous surface, brownish tinge when mature; 0.5 to 1.0 mm wide, solitary or coalesced, appearing in dense clusters throughout leaf lamina, concentrated along lateral veins; lower surface of gall with short conical projection bearing a shallow pit; mature galls with distinct fissure in the region of pit indicating surface of dehiscence; gall cavity divided into a dorsal and ventral half; inner margins soft, green and fleshy contrasting with hard outer surface; both upper and lower surfaces noticeably, glabrous.

Eriophyid: *Aceria* sp.

4. **Engelhardtia colebrookiana** Lindl. ex Wall.

Galls with major and minor protruberances: major outpushing either epiphyllous or hypophyllous, four lobed with deep pit between lobes; solitary or coalesced, more frequently along veins; gall surface with minute hair, apically twisted, turning brown with age; inner space four chambered fleshy, coinciding with outer lobes; single solitary gall about 2 mm wide, medium size leaf with 30-40 galls; minor protruberance often with an elongate stalk like projection; old galls dehisce along the groove between lobes.

Locality: Devalsari, altitude 2231.

Eriophyid: *Aceria* sp.

5. **Salix babylonica** Linn.

Minute, with epiphyllous growth pouch like, closed, bearing whitish straight,acute tipped hairs on surface; width not exceeding 1 mm, between 10-40 to a leaflet; undersurface marked by wide ostiole, margin of which is raised, bearing tuft of covering hair.

Locality: Thatyur; altitude 1900.
Eriophyid: *Eriophyes tetanothrix* (Nalepa).

6. **Berberis** sp.

Epiphyllous elongate pouch galls; minute, about 0.5 mm. long, not exceeding two in number on each leaf; outer surface of gall bearing sparse, fine transluscent hair; inner surface soft, fleshy; gall cavity spacious; under surface marked by minute ostiole.

Locality: Devalsari, altitude 2231.
Eriophyid: Undetermined.

7. **Prunus cerasoides** D. Don

Minute, blister like projections distributed on upper and lower surface of leaves, mainly along mid vein; surface of blister greenish when young, reddish brown when mature; gall cavity extremely small lined by irregular succulent growth, eriophyid mites tiny and escape from senescent galls through ruptures; only new and emerging leaves are infested.

Locality: Chamba, altitude 1676.

8. **Hedera nepalensis** Koch.

Galls minute, less than 1.0 mm wide, pustular and epiphyllous; under surface plugged by soft tissue; colour green above, pinkish below; sessile, usually solitary, sometimes coalesced and scattered on leaf surface; gall space restricted by fleshy irregular projections; internal space divided into two or three chambers; mites escape old galls through minute hypophyllous ostiole.

Locality: Magra, altitude 2000.
Eriophyid: *Aceria* sp.

9. **Quercus dilatata** Royle (Fig.2)

Epiphyllous projections about 1-3 mm wide, solitary or coalesced with dense mat of erinea on undersurface; erineal hair wavy, brown, glistening and turning opaque with age; mites found wandering at the base of erinea.

Locality : Magra, altitude 2000.

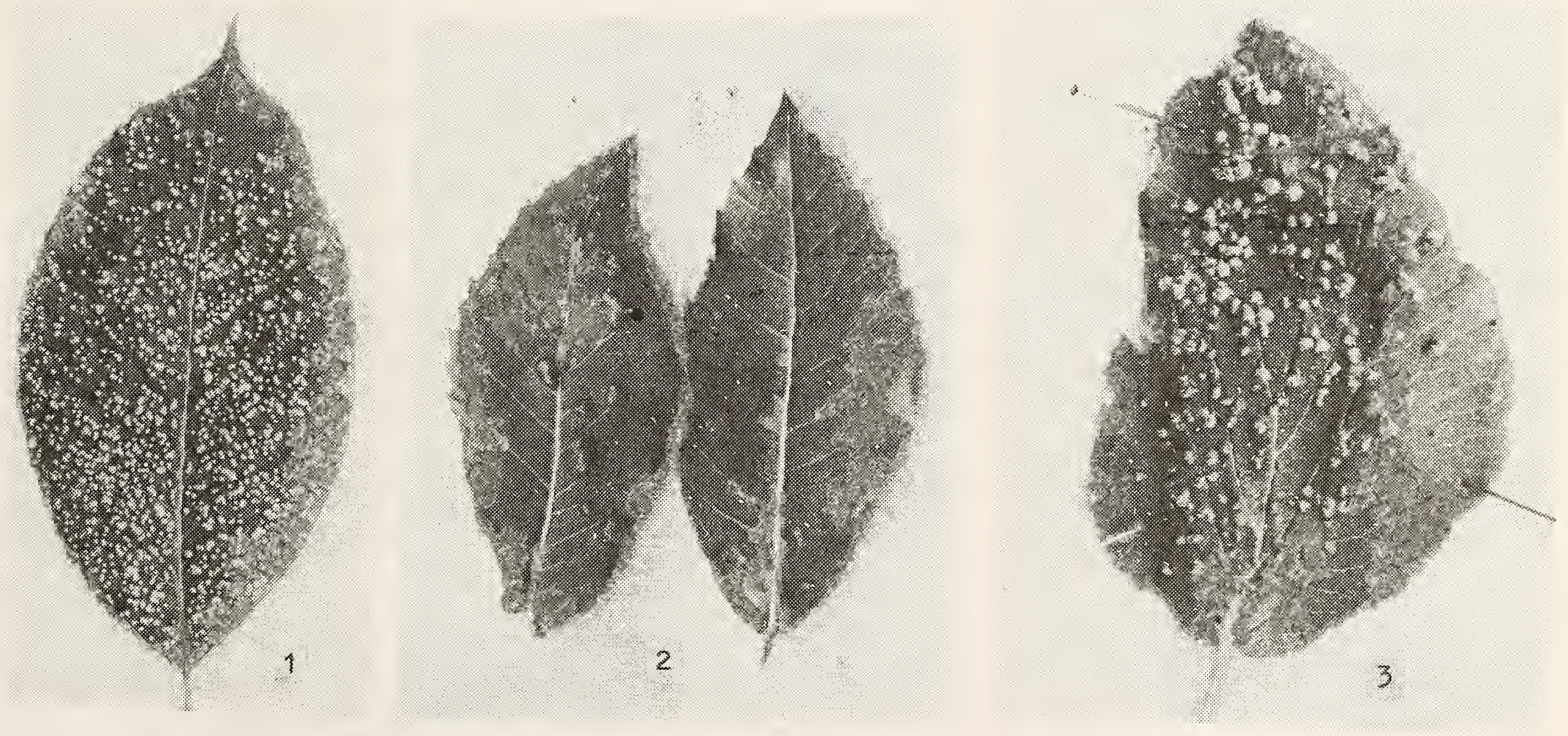

Fig. 1. *Juglans regia* Linn. ; Fig. 2. *Quercus dilatata* Royle ; Fig.3. *Viburnum cotinifolium* D. Don.

Eriophyid: *Aceria* sp.

10. **Viburnum cotinifolium** D. Don (Fig.3)

Thin epiphyllous pouch galls up to 1.0 mm in length; stalked, greenish, marked by presence of hair on surface; cluster of dense stellate hair covers the narrow undersurface ostiole; galls innumerable and scattered on particularly younger leaves.

Locality: Magra, altitude 2000.
Eriophyid: *Aceria* sp.

11. **Lyonia ovalifolia** (Wall.) Drude.

Malformation confined to swelling along the lower extremities of midveins and petioles, mainly on undersurface: swellings covered by transparent, fluid filled, blunt hair; colour of such hair turning reddish with age; mites found wandering and feeding among the hair.

Locality : Chakrata, altitude 2118.
Eriophyid: *Aculops* sp.

12. **Alnus nepalensis** D.Don

Epiphyllous, subcircular projections, 2-5mm wide, solitary or coalesced, scattered on the lamina: ostiole wide and hypophyllous; gall cavity filled with densely placed reddish succulent hair; hair whitish when young; infestation may reach petiole from leaf base.

Locality: Chakrata, altitude 2118.
Eriophyid : *Aceria* sp.

13. **Quercus leucotriphora** A. Camus

Essentially an erineal gall marked by diffuse patches of undersurface whitish hair; when not coalesced, patches 2-4 mm wide; hair stalked with bulbous succulent heads, whitish, turning yellowish with age; upper surface marked by weak projections, numerous and scattered.

Locality: Chakrata, altitude 2118.
Eriophyid: *Aceria triplacis* (Keifer).

14. **Indigofera heterantha** Wall. ex Brandis.

Minute epiphyllous galls 1-3 mm wide, sessile, subcircular confined to terminal leaflets and buds; cavity spacious with sparse, whitish subacutely tipped nutritive hair along inner lining; undersurface closed by a plug of soft hemispherical growth bearing hair on outer surface; about 1-3 galls per leaflet.

Locality: Koti Kanasar, altitude 2500.
Eriophyid: undetermined.

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April 26, 1993 BABUL DAS
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32. PORTUNID CRABS OF VISAKHAPATNAM COAST

Introduction

Eighty-seven species of crabs belonging to fourteen families have been collected from the Visakhapatnam coast. Among these, the family Portunidae was the most abundant. Among the 24 species listed two are first reports from the coast.

Material and Methods

The present study is based on a collection made over three years. Immediately after bringing the crabs to the laboratory the colour was noted. They were kept in refrigerator for a day to freeze them to prevent the shedding of the legs and chelae. After freezing, they were preserved in 10% formalin and later examined in detail.

Discussion

Sub-family: Podophthalminae
Genus : *Podophthalmus* Lamarck

1. *Podophthalmus vigil* (Fabricius 1798)

Speciments collected: Numerous.

An average male measures length = 23 mm and breadth of the carapace = 45 mm (excluding spine).

This species was collected from offshore fishing station, Visakhapatnam.

Sub-family : Catoptrinae
Genus : *Libystes* Milne - Edwards

2. *Libystes edwardsi* Alcock 1900

One female.

Length of carapace = 10 mm; breadth = 17 mm; breadth of the front = 4 mm.

Distribution: Arabian Gulf, Andaman, Gulf of Siam, Java Sea, China sea and India. A very rare crab collected from offshore fishing station, Visakhapatnam and the first report from Visakhapatnam coast.

Sub-family: Portuninae
Genus : *Scylla* de Haan

3. *Scylla serrata* (Forskal 1775)

An average male measures length of the carapace: 29 mm, breadth =48 mm; female length = 36 mm, breadth 48 mm.

Genus: *Lupocyclus* Adams & White

4. *Lupocyclus rotundatus* Adams & White 1848

Male length= 17 mm; breadth = 20 mm; female length = 12 mm; breadth =13 mm.

Genus: *Portunus* Weber

5. *Portunus argentatus* (Milne-Edwards 1861)

Male length = 39 mm; breadth = 41 mm; female length = 15 mm; breadth = 22 mm.

6. *Portunus gladiator* Fabricius 1798

Male length = 35 mm, breadth = 58 mm.

7. *Portunus gracilimanus* (Stimpson 1858)

Male length = 12 mm, breadth = 16 mm; female length = 11 mm, breadth = 16 mm.

8. *Protunus hastatoides* Fabricius 1798

Male length = 15 mm, breadth = 23 mm. female length = 15 mm, breadth = 20 mm.

9. *Portunus pelagicus* (Linnaeus 1766)

An average male measures length = 60 mm, breadth = 114 mm.

10. *Portunus sanguinolenthus* (Herbst 1783)

An average male measures, length = 54 mm, breadth = 87 mm. An average female measures, length = 46 mm and breadth = 80 mm.

Genus : *Charybdis* de Haan

11. *Charybdis (Charybdis) annulata* (Fabricius 1798)

Male length = 31 mm, breadth = 38 mm; female length = 33 mm, breadth = 50 mm.

12. *Charybdis (Charybdis) callianassa* (Herbst 1789)

Male length = 26 mm, breadth = 38 mm. (including lateral spine) ; female length = 19 mm, breadth = 31 mm.

13. *Charybdis (Charybdis) cruciata* (Herbst 1789)

Male length = 80 mm, breadth = 121 mm.

14. *Charybdis (Charybdis) lucifera* (Fabricius 1798)

Male length = 41 mm, breadth 65mm, female length = 27 mm, breadth = 36 mm.

15. *Charybdis (Charybdis) miles* (de Haan 1850)

Male length = 45 mm, breadth = 61 mm, female length = 33 mm, breadth = 42 mm.

16. *Charybdis (Charybdis) natator* (Herbst 1789)

Male length = 36 mm, breadth = 52 mm, female length = 36 mm, breadth = 50 mm.

17. *Charybdis (Charybdis) orientalis* Dana 1852

Male length = 22 mm, breadth =34 mm; female length = 37 mm, breadth = 53 mm.

18. *Charybdis (Charybdis) rostrata* Milne-Edwards 1861

Male length = 17 mm, breadth = 24 mm.

19. *Charybdis (Charybdis) variegata* (Fabricius 1798)

Specimens collected : 3 males and 5 females.

Male length = 21 mm, breadth = 29 mm; female length = 17 mm breadth = 22 mm.

20. *Charybdis (Goniohellenus) edwardsi* Leene and Butendijk 1949

Male length = 49 mm, breadth = 58 mm; female length = 35 mm, breadth = 44 mm.

Distribution: Martaban, Port Natal, East Indies, East coast of Africa, Malabar coast of India.

This species, collected from offshore fishing station, Visakhapatnam, is the first report from Visakhapatnam coast.

21. *Charybdis (Goniohellenus) hoplites* (Wood-Manson 1877)

Male length = 15 mm, breadth = 19 mm female length = 13 mm, breadth = 17 mm.

22. *Charybdis (Goniohellenus) truncata* (Fabricius 1798)

An average male measures, length = 29 mm, breadth = 29 mm; an average female measures length = 20 mm and breadth = 29 mm.

23. *Charybdis (Goniohellenus) vadorum* Alcock

1899

Male length = 13 mm, breadth = 17 mm, female length = 16 mm, breadth = 19 mm.

24. *Thalamita crenata* (Latrielle 1829)

Female length = 35 mm, breadth = 52 mm.

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33. MARINE GASTROPODA OF BOMBAY - A RECENT SURVEY

INTRODUCTION

This checklist of gastropod fauna along the Bombay coast is based on a five-year survey (1987 - 1991) of various beaches such as Colaba (T.I.F.R), Mahim, Bandra, Versova, Madh island, Khar Danda and Juhu.

RESULTS AND DISCUSSION

Subrahmanyam *at al.* (1952) Illustrated a total of 187 species of the gastropods for Bombay and listed 61 species. Of these, a few had previously been recorded by Melvill and Ambrecrombie (1893) and Melvill and Standen (1901).

In the present survey, only 102 species were recorded (except the minute shells). Minute shells from various families mentioned below were not studied.

Family	Species	Family	Species
Cyclostrematidae	1	Hydrobiidae:	3
Rissoidae	7	Tiariidae	1
Finellidae	1	Triphoridae	1
Eulimidae	1	Pyramidellidae	11
Fossaridae	3	Magilidae	1
Acteonidae	1	Cavolinidae	1

Out of 102 species six are newly recorded. Thus only 96 species out of 187 species (according to previous records) are present along various beaches at Bombay.

TABLE 1

ARCHIOGASTROPODA

1. *Cellana radiata* (Rod.)
2. *Scutus unguis* (Linn.)
3. *Diodora bombayana* (Sowb.)
4. *Trochus radiatus* (Gme.)
5. *Euchelus asper* (Gme.)
6. *E. tricarinatus* (Lam.)
7. *Clanculus ceylanicus* (Nev.)
8. *Isanda crenulifera* (A.Ad.)
9. *Umbonium vestiarum* (Linn.)
10. *Turbo brunneus* (Rod.)
11. *Astraea stellata* (Gme.)
12. *A. semicostata* (Linn.)
13. *Nerita crepidularia* (Lam.)
14. *N. albicella* (Linn.)
15. *N. oryzarum* (Rec.)
16. *Architectonica laevigata* (Lam.)

MESOGASTROPODA

17. *Cypraea arabica* (Gme.)
18. *C. lentiginosa* (Gray)
19. *Volva sowerbyna* (Wien.)
20. *Tibea curta* (Sowb.)
21. *Tonna dolium* (Linn.)
22. *T. allium* (Dill.)*
23. *T. fasciata* (Lam.)*
24. *Ficus ficus* (Rod.)
25. *Bursa spinosa* (Lam.)
26. *B. tuberculata* (Brod.)
27. *Natica maculosa* (Lam.)
28. *N. picta* (Rec.)

29. *N. lineata* (Lam.)
30. *N. rufa* (Born.)
31. *N. didyma* (Bolten)
32. *N. pulcaria* (Phil.)
33. *Planaxis sulcatus* (Born.)
34.*P. acutus* (Krauss)
35. *P. similis* (Smith)
36. *Cerithium morus* (Lam.)
37. *C. rubus* (Desh)
38. *Potamidis cingulatis* (Linn.)
39. *Telescopium telescopium* (Linn.)
40. *Mitra obeliscus* (Reeve)
41. *M. circula* (Kienner) *
42. *Chrysame ambigua* (Swain.)
43. *Acrilla acuminata* (Sowb.)
44. *Janthina roseola* (Reeve)
45. *Turritella duplicata* (Linn.)
46. *Vermatis* sp.
47. *Littorina intermediata* (Phil.)
48. *L. undulata* (Gray)*
49. *Tectarius malacanus* (Phil.)
50. *Xenephora solaris* (Linn.)

NEOGASTROPODA

51. *Murex adustus* (Lam.)
52. *M. tribulus* (Linn.)
53. *Thais caranifera* (Lam.)
54. *T. rudolphi* (Lam.)
55. *T. bufo* (Lam.)
56. *T. tissoti* (Petit)
57. *T. sacellum* (Lam.)
58. *Drupa tuberculata* (Blain)
59. *D. hippocastanum* (Lam.)
60. *D. konkanensis* (Mel.)
61. *D. contracta* (Ree)
62. *Ocinebra bombayana* (Mel.)
63. *Conus piperatus* (Ree)
64. *C. mutabilis* (Ree)
65. *C. monachus* (Linn.)
66. *C. cumingii* (Ree)*
67. *Terebra capensis* (Smith)
68. *Surcula javana* (Linn.)
69. *S. fulminata* (Kie)
70. *S amicta* (Smith)
71. *Clavus crassa* (Smith)
72. *Babylonia spirata* (Linn.)
73. *Nassarina suturalis* (A. Ad.)
74. *Cantharus spiralis* (Gray)
75. *Polia rubiginosa* (Ree)
76. *Engina zea* (Mel.)
77. *Oliva gibbosa* (Born.)
78. *Oliva nebulosa* (Lam.)
79. *O. nebulosa intricata* (Mar.)
80. *Nassarius canaliculata* (Schp.)
81. *N. olivaceous* (Brug)
82. *N. ornatus* (Kienner)
83. *N. jacksoniana* (Q. & G.)
84. *N. mucronatus* (A.Ad.)
85. *N. pictus* (Dkr.)
86. *N. lentiginosus* (A. Ad.)
87. *Zeuxis caelatus* (A. Ad.)
88. *Cyllene fuscata* (A. Ad.)
89. *Bullia lineolata* (Wood)
90. *Nassa thersitis* (Brug)
91. *Pyrene scripta* (Lam.)
92. *P. terpscichore* (Sowb.)
93. *Cancellaria costifera* (Lam.)
94. *Hemifusus pugilinus* (Born.)
95. *Pila doloides* (Ree)
96. *Ellobium auris jude* (Linn.)
97. *Cassidula nucleus* (Gme.)
98. *Melampus sincaporensis* (Pfi.)
99. *M. coffea* (?)
100. *Siphonaria basseinensis* (Mel.)
101. *Pyramidella pulchella* (A. Ad.)
102. *Drilla atkinsoni* (Smith)

Species marked * are new records from the Bombay coast.

A detailed checklist is given in Table 1. This shows that many species have disappeared from the Bombay coast. Five of the six species which are newly recorded have been collected from the beach behind the Tata Institute of Fundamental Research, at Colaba. This is a protected beach, such small pockets of protected beaches can provide a safe habitat to these delicate and highly vulnerable molluscs.

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34. FLORAL BIOLOGY OF *COUROUPITA GUIANENSIS* AUBL. (LECYTHIDACEAE)

INTRODUCTION

Couroupita a genus of Lecythidaceae has about 15 species abundantly distributed in the neotropical forests of South America and West Indies. *C. guianensis* is one of the species commonly known as "cannon-ball" or "snake-jasmine" tree is cultivated in India. Its flowers are fragrant and present a pleasing combination of rosy purple, white and yellow colours. The published data on the floral biology of this species was based on the trees from Neotropics only (Ormond *et al.* 1981: Yarsick *et al.* 1986) and even the available information is preliminary in nature. Similar data are lacking from the Old World tropics. The present paper is therefore a good occasion to describe the floral biology of *C. guianensis* from India. The study was made on the tree at the Andhra University, Visakhapatnam in Andhra Pradesh.

FLORAL BIOLOGY

C. guianensis flowers almost throughout the year with heavy flowering in February and March. It exhibits 'cauliflory' by producing flowers in clusters on the trunk and main limbs. The flowers are nectarless but produce abundant pollen. The androecium is characterised by stamens of the ring and hood which are connected by a stamen-free ligular structure. Ring pollen is fertile while the hood pollen is sterile in that the latter does not produce germ tubes. Approximately 450 grains are produced per ring anther of which 80% have the viability to germinate. Gynoecium is syncarpous with a style in the shape of a truncated cone. The stigma has a starlike fissure with six to eight points that correspond to the number of carpels.

The flowers open simultaneously around dawn. Flower-buds mature by evening and transform into fully-open flowers by 0700 h. The plants in Venezuela have flowers opening asynchronously between 0700 and 0830 h with a peak flower production around 0800 h (Ormond *et al.* 1981). Temporal differences in the anthesis period in different geographic regions may have been due to the prevailing climatic conditions. Anthers of both ring and hood stamens dehisce simultaneously in longitudinal fashion shortly after anthesis as reported by Yarsick *et al*. (1986). The floral fragrance is released into the atmosphere through osmophores present in the corolla and in the top of the filaments of hood anthers. Similar situation of release of sweet odors is also found in other genera of Lecythidaceae (Mori *et al.* 1978). It was this aroma of the flowers that attracts the pollinators. The hood stamens serve as "feeding stamina" while the ring stamens as "pollinating stamina". The androecium of this nature with dimorphic pollen is a clear case of heteranthery. Heteranthery is well developed in Lecythidaceae but as a rule, it is a characteristic of plants that exhibit poricidal anther dehiscence, e.g. *Cassia* spp. and Melastomataceae (Buchmann 1983).

C. guianensis is foraged by carpenter bees of *Xylocopa latipes* and *X. pubescens,* the honeybees of *Apis florea* and *A. cerana indica* and the stingless bee of *Trigona* spp. The bees forage from dawn to noon. Carpenter bees while entering the flower push the hood down causing the release of pollen tetrads that simultaneously adhere to the ventral part of the bee and are accessible for grooming. After entering the flower, the carpenter bees, collect pollen from the hood and during the pollen collection they rub their dorsal parts against the ring anthers and the stigma detaching several ring anthers in the process. This behaviour results in nototribic pollination. Other bees wander in the flower but pollination by them is an accidental phenomenon. It is concluded that carpenter bees are the only insects effective in promoting cross-pollination in *C. guianensis* in India. Studies by Ormond *et al.* (1981) and Yarsick *et al.* (1986) also record the tree is exclusively pollinated by carpenter bees and the other bees, wasps, flies and thrips foraging are mere visitors in Brazil and Venezuela of the new World. Carpenter bees are therefore required for the success of pollination and subsequent fruit production in *C. guianensis* which is an obligate outcrosser (Ormond *et al.* 1981).

The research was made while the first author was under Pool Officers' Scheme (CSIR), New Delhi.

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35. *SPILANTHES ULIGINOSA* SW. (ASTERACEAE) - A NEW RECORD FOR GANGETIC PLAIN

(With a text-figure)

While working on *Spilanthes* Jacq. I came across two interesting plant specimens, one collected from Ranchi district, Bihar and other from Lucknow, Uttar Pradesh. After a critical study they were identified as *Spilanthes uliginosa* Sw. This species is not so far recorded from Gangetic Plain (Hooker 1904, Sivarajan and Mathew 1984, Sivarajan and Remesan 1987). A detailed description with ecological notes and illustration is provided.

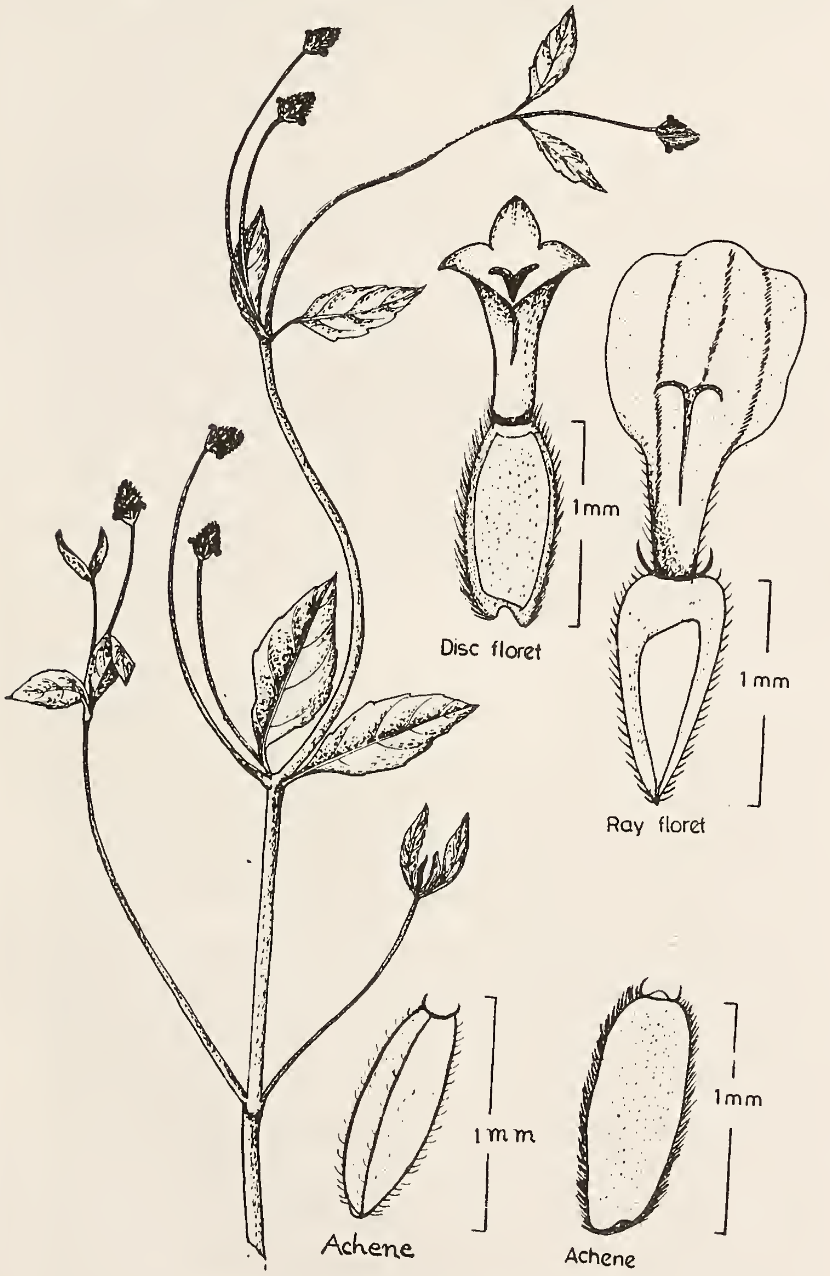

Fig. 1. *Spilanthes uliginosa* Sw.

Spilanthes uliginosa Sw. Nov. Gen. Pl. Seu Prod. Descr. Veg. Ind. Occ. 110. 1788; DC. Prodr. 5: 264. 1836; Sivarajan et Remesan, Jour. Econ. Tax. Bot. 10(1); 146. 1987. *S. iabadicensis* A. H. Moore, Prod. Amer. Acad. Art. Sci. 42 (20): 524. 1907; Koster & Philipson, Blumea 6: 354. 1950; Grierson, Rev. Handb. Fl. Ceyl. 1: 221. 1980 (Fig. 1).

Erect-ascending herbs up to 60 cm high. Stem terete, often rooting at lower nodes, weak, slightly hairy. Leaves up to 4 cm long and 1.5 cm broad, ovate or ovate-lanceolate or lanceolate in upper portion, acute, often unequal at base, margin coarsely serrate or serrate, petiole up to 1 cm long, Heads rayed, ovate or younger ones suborbicular (in pressed specimens), up to 1 cm long and 0.5 cm broad; peduncles up to 5 cm long; involucral bracts ovate-oblong, pubescent, veined; palea up to 0.25 cm long, nearly boat shaped, acute, fimbriate; ray florets 4-6, female, up to 0.28 cm long, corolla tube with bulbous base, inflated towards the middle, inflated portion 3 - lobed, middle one larger than laterals; style exerted from the corolla tube near the inflated portion, stigma bilobed, recurved; disc florets numerous, 0.2 cm long, corolla tube up to 0.13 cm long with bulbous base, 4 lobed at the top, lobes ovate, spreading or recurved at the top, acute. Achenes *c.* 0.1 cm long, dimorphic, trigonous or laterally compressed and often ridged in the middle.

Distribution: Probably a native of Tropical America and has been reported from Africa, Sri Lanka and Java. In India it is recorded from Andman-Nicobar, Sikkim Himalaya and Tamil Nadu. In Ranchi and Lucknow, It is found growing in moist places in cultivated fields.

Specimens examined: Singh 5695 (Ranchi) CIMAP; Singh 5937 (Lucknow) CIMAP.

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36. *PORANA VOLUBILIS* BURM.F. (CONVOLVULACEAE)- A NEW RECORD FOR ANDAMAN FLORA

INTRODUCTION

An interesting species of *Porana* was collected from two localities around Port Blair by us and later identified as *Porana volubilis* Burm. f. (Convolvulaceae), a species hitherto unknown to occur in these islands Parkinson (1922) and Rao (1986). Gamble (1921) in the flora of "*Presidency of Madras*" writes that this is a Malay species also common in gardens on both coasts of Peninsular India which in turn is corroborated by Henry *et al.* (1987). Kurz says this species extends to Khasi and Roxburgh cites that it grows in various parts of India but is scarce in Bengal and flowers during the cold season in botanic garden, but the only example seen are Malayan or cultivated (Hooker 1876). The Present collection of this species has been made from natural wild habitats.

Porana volubilis Burm. f. Lamk. Ill. t. 186; Roxb. fl.Ind. i.465 & ed. Carey & Wall. ii. 40; Blume Bijd. 723; Wall. Cat. 1327; Don Prodr. 99; Wight III.168 bis, fig, 8 & Ic. t. 347; Chois. Convolv. Or. 106, and in DC. Prodr. ix.436; Kurz in Trimen. Journ. Bot. 1873, 137 & For. Fl. ii. 220; clarke in Hook. f. Fl. Brit. India 4: 222. 1876; Gamble Fl. Pres. Madras 2: 921. 1921.

Large climber ascending tall tree; branches cylindrical, warted, glabrous except the young branches. Leaves simple, estipulate, petiolate, lamina ovate, acuminate, base cordate - subcordate, 2.5 - 6 x 1 - 4.3 cm, entire, glabrous; lateral veins 8-11 pairs, looping away from the margin ; petiole 0.7 - 1.7 cm long tawny pubescent. Panicles axillary 12.5 cm long tawny pubescent. Flowers pedicellate, pedicel up to 3 mm long, tawny pubescent bracteate, bracts up to 1.5 mm long, tawny pubescent , bracts several on the base of pedicels and one longer than others under its insertion; Calyx 0.5 -0.6 cm long, 5 lobed, sepal lobes oblong, tawny pubescent joined at base; Corolla sparsely tawny pubescent, campanulate, 1 cm long, white, limbs distinctly 5 lobed ; stamen 5, 0.3 cm long, glabrous, subincluded, filament filiform; slender ; anthers 0.1 cm long, dorsifixed, on the corolla tube; Pistils 0.5 cm long, style up to 0.4 cm long glabrous, bipartite, one of the division slightly shorter, exerted, stigma small, capitate, ovary 2 lobed, tawny pubescent at the distal end, seated on a glabrous disc; Fruit capsule, globose, sepals in fruit all equal, subspathulate with longitudinal not very prominent nerves.

Distribution: Burma, Thailand, malaya, India and Andaman Islands.

Specimens examined : Andaman Islands, South Andamans, Carbyn's Cove, Port Blair, fl. 25-xii -89, A.R.P. Sinha 0059; South Andamans, South point, Prot Blair fl. 7-xi -91, A.R.P. Sinha & Krishna Kumar 0417.

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37. ADDITIONS TO THE *ALLIUM* SPECIES OF THE FLORA OF CHAMOLI, UTTAR PRADESH HIMALAYA

(With two text-figures)

Allium L. (Amaryllidaceae) has 700 species confined chiefly to the northern temperate and alpine zones of the world, i.e. Europe, northern, middle, south-east Asia, North- West America and the Altai mountains (Jones and Mann 1963, Santapau and Henry 1973, Kunkel 1984, Buijsen 1990). Hooker (1892) has recorded 31 species from India. So far 30 species have been reported from temperate and alpine zones of northern Himalaya in India. Occasionally a few of them are cultivated locally (Collett 1902, Duthie 1903-1929, 1906; Kachroo *et al.* 1977, Mani 1978, Dhar and Kachroo 1983, Negi and Pant 1990, 1992, Negi and Gaur 1991).

During multicrop/region specific/crop specific and ethnobotanical explorations during the years 1986-1988 in district Chamoli, Garhwal Region of Uttar Pradesh Himalaya we collected six species of *Allium* among which four species were grown widely in kitchen gardens and backyards locally while two species were found in the wild.

After critical morphological studies and comparisons with authentic collections preserved in northern circle. Botanical survey of India (BSD) and Forest Research Institute, Dehradun (DD), specimens were identified as *Allium ampeloprasum* L., *A.ascalonicum* L., *A. auriculatum* Kunth, *A. cernuum* Roth, *A. griffithianum* Boiss. and *A. tuberosum* Rottl. ex Spreng. Comparisons of taxonomical characteristics, distribution, habitat, method of utilization of the four species of semi-domesticate *Allium* are presented in Table 1, while two wild and endemic *Allium* species are described in detail.

The present report of their occurrence and cultivation forms additions to the flora of Chamoli, U.P. Himalaya (Kala and Gaur 1982, Naithani 1984). These species are also not included by Polunin and Stainton (1984).

A detailed description alongwith figures of the specimens are provided here to facilitate further collection easy identification. Seeds/bulbs/cloves and plant specimens have been rejuvenated, multiplied and maintained at NBPGR, Regional Station-Bhowali.

Allium auriculatum Kunth, Enum. 4: 418. 1843; Baker in Journl. Bot. 295. 1874; Hook. f. FBI 6: 342. 1892; Duthie 188. 1906 (Fig.1).

(Loc. - *Pharan*)

Glabrous herb 60.0-75.0 cm long. Bulb elongate, narrow, 10.5 - 12.5 x 0.5 - 1.0 cm; scales brown, red, reticulate. Leaves 5 -10, narrowly linear, flat, 15.5-35.0 x 0.2-0.4 cm, obtuse, stout. Scape erect, solid, 40.0-50.0 x 0.2- 0.6 cm, exceeding the leaves. Inflorescence globular umbel, fertile, bulbils present. Tepels 0.4-0.6 cm, oblong to ovate, pink-purple. Pedicels 1.2 -1.5 cm long. Stamens longer than the perianth. Filaments arising from the basis of tepels, 1.0-1.5 cm long. Anthers 0.3-0.6 cm long, yellow. Seeds 0.2-0.4 x 0.1-0.2 cm, black.

Flowering and fruiting: May-August.

Distribution and Ecology: M.N. Koppar and K.S. Negi, NBPGRH-301, BSD 87001, Brahm Mathya-Malari, district Chamoli, 3800 m, July 1988; BSD 49025, Spiti, 4100 m, BSD 52146, Zanskar, Ladakh, 4600 m, BSD 54724, BSD 83129, Zanskar, Tangtse, Ladakh, 4300 m, July 1973, DD 2279, DD 68746, between Da and Hanle, Rupshu, Kashmir, 4100 m July 1931; native to India and Oriental region.

There is no recent compilation or elaborate and significant account regarding the food value of the species, either from India or else where in the world.

Habitat: Found wild in alpine, sub-alpine and sub-arctic zones from 3500- 5000 m. Common on flat rocks, stony slopes and screes.

Uses: Dried leaves and flowers are used for flavouring or seasoning *dal. curry, meat.* Leaves are extensively employed in the preparation of *masalas* or curry powder.

Allium griffithianum Boiss., Diagn. Ser. 2,4: 117. 1959; Nasir, FWP 83: 20, 1975.

A. rubellum M.Bieb. var. *grandiflorum* Boiss., Fr. Oriental. 5: 253. 1882; Hook. f. FBI 6: 339. 1892. *A.tenue* C. Kotch in Linnaea, 22: 238. 1849. *A. jacquemontii* Kunth, Enum. Pl. 4: 399. 1843. *A. longisepalum* Bert. in Nov. Common. Acad. Bonon. 5: 429. 1842. (Fig.2).

(Loc.- *Pharan, Jamboo*)

Erect herb up to 50 cm. high. Bulb small, solitary, clustered, ovoid, outer scale fibrous, membranous, produced into a long neck. Leaves 4-6, basal, half-round or flattish, 10.0-25.0 x 0.1 - 0.3 cm. Scape terete. 30 cm. long not exceeding the leaves. Inflorescence terminal dense flowered globose, fertile, 1.0-2.0 cm dia., bulbils absent.

Table 1

COMPARISONS OF TAXONOMICAL CHARACTERISTICS, VERNACULARS, DISTRIBUTION, HABITAT AND METHOD OF UTILIZATION OF SEMI-DOMESTICATED *ALLIUM* SPECIES

S.No 1	*Allium ampeloprasum* L. (V.-Hargandh, Sidhum, Vilati lahsoon) 2	*Allium ascalonicum* L. (V.- Dunna, Dhun, Chapi, Palandu, Pyazi 3	*Allium cernuum* Roth (V.- Sikwa) 4	*Allium tuberosum* Rottl. ex Spreng. (V.-Markua,Bang-gandina) 5
1.	Herb upto 150 cm tall	Herb upto 50 cm high.	Herb upto 75 cm high.	Herb upto 80 cm long.
2.	Bulb ovoid to oblong, main bulb with many young sprouts (bulbils), more than 50, cloves 8 - 14.	Bulb globose to ovoid,, severalbulbcoat purplish, brownish or red, greenish-white.	Bulb elongate, clustered, outer bulbcoat membranous, purplish or pink.	Bulb swollen an enlarged, elongat several set on a rhizome, bulbcoat netted fibrous, white fleshy or pale brown.
3.	leaves 4-15, glabrous, flat dentate.	Leaves 4-8, basal, fistular, dark green.	Leaves several,6-8, linear, flat.	Leaves 4-9, distichous, glabrous, flat.
4.	Flowers white to dark purple sterile.	Flowers white, occasionally appear,sterile.	Flowers pink, rosy or white occasionally appear, sterile.	Flowers white, fertile.
5.	Flowering: April-July.	Flowering: March-May.	Flowering: June- September.	Flowering: July-October.
6.	Semi-domesticate, upto 3000 m, M.N.Koppar and K.S.Negi, KN-747, Tolma, District-Chamoli,2500 m, July 1988;NBPGRHH-325.	Semi-domesticate upto 2500 m, M.N.Koppar and K.S. Negi, KN-704, Kurhur, district-Chamoli,2500 m, July 1988; NBPGRH-288.	Semi-Domesticate upto 1500 m K.S. Negi,Gopeshwar, Dist. Chamoli, 1500 m, June 1988; NBPGRH-368.	Semi-Domesticate upto 2000 m, K.S. Negi, N-896,Siroli,Gopeshwar Mandal, District-Chamoli,2000 m, October1988 ; NBPGRH-215.
7.	Pseudostem and leaf blades are cooked as vegetables. Cloves are utilized as a pickles and spices.	Leaves and leaf bases (young bulbs) are used to adulterate in many food dishes, often fresh as garnishing. Bulbs are frequently used for flavouring food either raw, cooked or fried.	Bulbs are used for flavouring and also pickled	Fresh leaves mostly green are used as condiments in various local food dishes.
8.	Native to south Europe,north Africa, middle-east into west USSR and Caucasus to Iran, cultivated throughout south east Asia.	Native to north Africa and east Mediterranean region, cultivated in USA,Europe, Africa, the Caribbean countries and Asia.	Native to new world	Native to east Asia, cultivated from east Mangolia to Japan, Siam, the Philippines, Indonesia, Malaysia, and through Thailand to north India Western Himalaya, Khasi hills, Bengal.

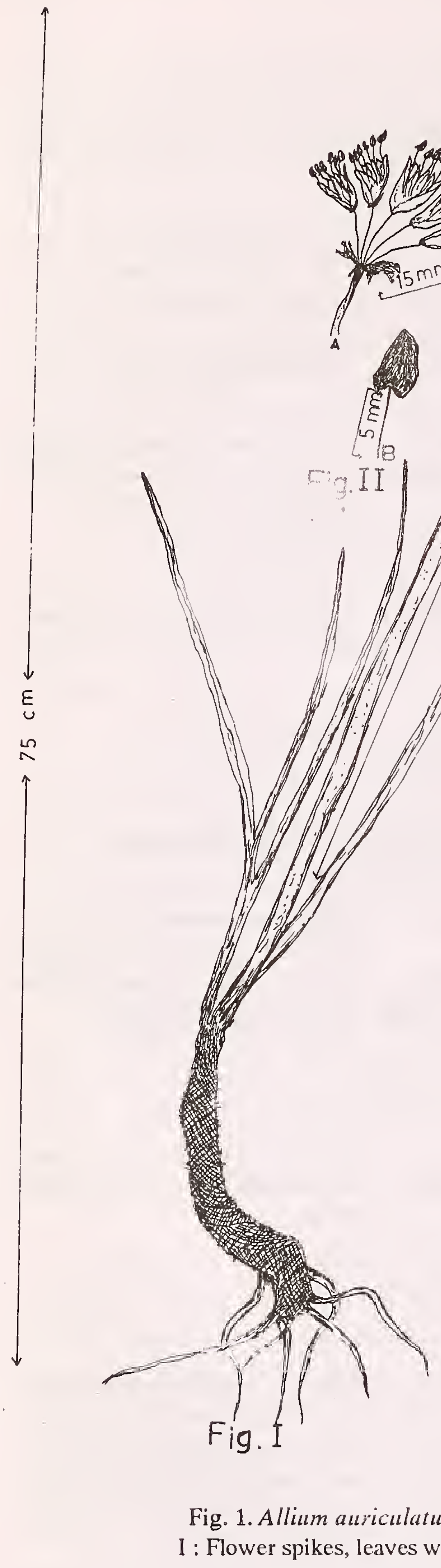

Fig. 1. *Allium auriculatum* Kunth
I : Flower spikes, leaves with bulbs ;
II : A. Floral heads, B Reproductive (Anthers).

Tepels bell shaped, 0.4-0.6 cm long, oblong to ovate, pink or rosy or pale yellow. Pedicels 1.2-1.5 cm long. Stamens longer than the perianth. Filaments included, cohering at the base, 0.8 1.0 cm long. Seeds black.

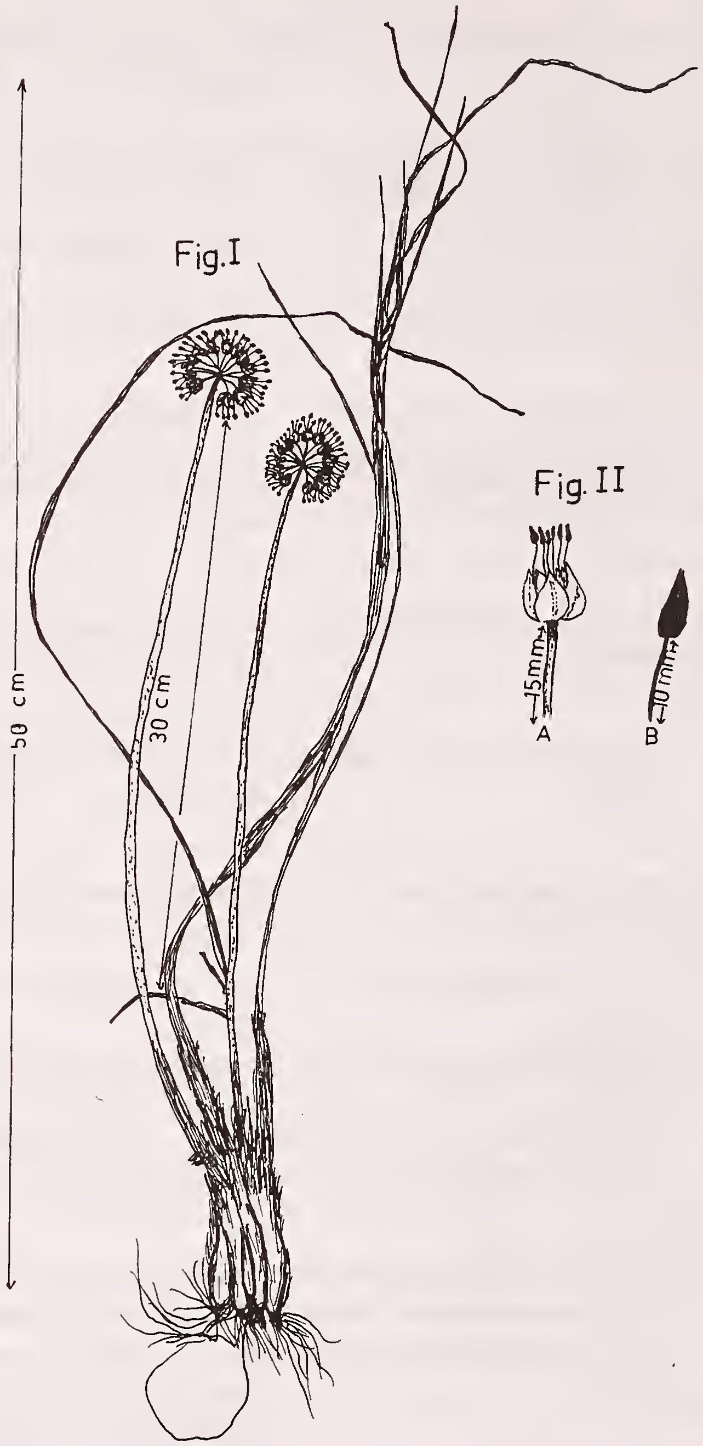

Fig. 2. *Allium griffithianum* Boiss.
I : Flower spikes, leaves with bulbs ;
II : A. Floral heads, B Reproductive (Anthers).

Flowering and fruiting: August-December.

Distribution and Ecology: M.N. Koppar and K.S. Negi- KN-748, Tolma, District - Chamoli, 2500 m, July 1988: KN-749, Kailashpur-Malari, District- Chamoli, 3160 m, July 1988, KN-780, Bampa-Neeti, District- Chamoli, 3370 m, July 1988: KN-795, Brahm- Mathya - Malari, district- Chamoli, 3500 m, July 1988; KN-804, Sukhi, district - Chamoli, 2400 m, July 1988; KN-819, Mana- Badrinath, district- Chamoli, 3200 m, July 1988; NBPGRH 135; BSD 45936, Trilokinath, Upper Chenab, Himachal Pradesh

Native to south Africa, Europe, Siberia westward to the Ural.

Habitat: Found Wild in sub-alpine and alpine Himalaya from 2500-4000 m altitude, Common on flat rocks.

Uses: The plant is used as a carminative.

ACKNOWLEDGEMENTS

We thank the authorities of northern circle, BSI and TAxonomy Branch, FRI, Dehradun for herbarium consultation. We are grateful to the Director, Dr. R.S.Rana, NBPGR, Pusa, New Delhi and Prof. R.D. Gaur, Department of Botany, Sh. H.N. Bahuguna, Garhwal University, Srinagar for encouragement

April 20, 1992

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38. NOTES ON THE DISTRIBUTION OF SOME GRASSES

During the course of Ethnobotanical studies in Andaman and Nicobar Islands in 1987, we collected about seventy-five grasses from Bay Islands.

A critical examination of these grass species reveals that *Brachiaria miliiformis, Echinochloa glabrescens, Eulalia trispicata, Ischaemum* *thomsonianum* and *Lepturus repens* are new to Andaman and Nicobar Islands flora.

Brachiaria miliiformis (Presl.) A. Chase in Contrib. U.S. Nat. Herb. 22, 25 (1920); Fl. Madras, 3, 1226 (1967-Reprinted); Fl. Brit. Ind. 7,32 in part (1896).

Panicum miliiforme J. Presl. ex C. Presl., Rel. Haenk, 1, 300 (1830).

Recorded from Assam, Bihar, West Bengal, Tamil Nadu and Kerala.

Coll.: *Roy & Pal* 16830.

Echinochloa glabrescens Munro ex Hook . f., Fl. Brit. Ind. 7, 31 (1896).

According to Bor (1960) the grass is found in Himalaya from Afghanistan eastwards, Khasi Hills.

Coll.: *Roy & Pal* 16870.

This species is very close to *Echinochloa crusgalli* (L.) P. Beauv. var. *crusgalli* but differs in having the peculiar type of indurated lower lemma.

Eulalia trispicata (Schult.) Henr. in Blumea 3,453 (1940); Fl. Madras, 3, 1189 (1967 - Reprinted).

A. tristachyus Roxb. Fl. Ind. I. 261 (1820) *non* H.B.K. (1816). *A. trispicatus* Schult., Syst. Veg. 2, Mant. 452 (1824).

Recorded in Andhra Pradesh, Assam, Bihar, Karnataka, Kerala and in Jammu-Kashmir.

Coll.: *Roy & Pal* 16877.

Ischaemum thomsonianum Stapf ex C.E.C. Fischer in Gamble, Fl. Madras 1722 (1934); Fl. Madras, 3, 1193 (1967- Reprinted).

I. murinum Hook. f. Fl. Brit. Ind. 7, 135 (1896) non Forst (1786).

According to Bor it is found only in Karnataka.

Call.: *Roy & Pal* 16821.

Lepturus repens (G. Forst) R. Br., Prodr. Fl. Nov. Holl. 207 (1810); Fl.Brit. Ind. 7,365 (1896).

According to Bor it is found in Laccadives only.

Coll.: *Roy & Pal* 16829.

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May,18, 1992
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Howrah 711 103.

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39. A FEW TAXA NEW TO EASTERN INDIA WITH ANNOTATIONS ON DISTRIBUTION

The central part of India is well-explored area. Nevertheless, an analysis of the 772 taxa collected from Sambalpur District, Orissa (India) during 1986-1990 (Panda 1990) the following taxa were new to the floristic records of Eastern India.

Hedyotis caerulea Wt. et Arn., Prodr. : 412. 1834: J.D. Hook in J.D. Hook., Fl. Brit. India 3: 60. 1880; Manilal & Sivarajan, Fl. Calicut: 141. 1982 (Rubiaceae).

Oldenlandia caerulae (Wt. et Arn.) Gamb., Fl.Pres. Madr.: 597. 1921.

Specimen cited : Brook's Hill, Sambalpur, 21.9.1988, *Das* et *Panda* 1172.

Fl.& Frt.: August -February.

Frequency: Rare.

Ecology: Found on moist loamy-lateritic soil, in open places, growing mixed up with *Dentella repens* (L) J.R. & G. Forst., *Hedyotis corymbosa* (L.) Lam., *Tridax procumbens* L. , *Justicia diffusa* Willd., etc.

NOTE: Previously the species was known to be endemic to Sri Lanka and Peninsular India (Maharashtra, Karnataka, Kerala and Tamil Nadu). This collection of the taxon from Sambalpur district is a new record for Orissa and Eastern India, and extends its northern distributional limit into Orissa.

Heliotropium zeylanicum (N.L.Burm.) Lam., Ency. 3: 94. 1789.

ssp. *zeylanicum*: Kazmi in J.Arn. Arbor. 51: 156. 1970-Plate 72e; Mathew, Fl. Tamil Nadu Carnatic Pt. 1: 990. 1983 (Boraginaceae).

H. curassavicum L. var. *zeylanicum* N.L. Burm., Fl. Ind. : 41, t. 16, f.2. 1768. *H. linifolium* Lehm., Pl. Asperif. : 35. 1818 Wt. Ic. t. 1391.1848. *H. paniculatum auct. non* R. Br. : C.B. Clarke in J.D. Hook., Fl. Brit. India 4: 151. 1883, *p.p.*

Specimen cited: Kholbilung, 3.11.1986, *Das* et *Panda* 227; Nrusimhanath, 6.4.1988, *Das* et *Panda* 1029.

Fl. & Frt. : January-December.

Frequency: Often found at Kholbilung, Nrusimhanath, Deogarh and Badrama.

Ecology: Seen in open places on moist loamy soil, growing in association with *Polygala arvensis* Wild., *Euphorbia hirta* L. , *Phyla nodiflora* (L.) Greene, *Borreria pusilla* (Wall.) DC., etc.

NOTE: This report of the taxon from Sambalpur district, results in a new record for Orissa, also for Eastern India. So far, it has been recorded from Sri Lanka, Peninsular and Western India (Tamil Nadu,Rajasthan), Trop. Africa. The epithet *'zeylanicum'* may possibly indicate its origin as Sri Lanka.

Hemigraphis crenata (Benth. ex Hohenack.) Bremek. in Mat. mon. Strob. : 137. 1944; Pandey et Singh in Shetty et Singh, Fl. Rajasthan 2: 649. 1991 (Acanthaceae)

Ruellia crenata Benth. ex Hohenack. in Flora 32 : 558. 1849; *Hemigrphis elegans* (Hook.) Nees var. *crenata* (Benth. ex Hohenack.) C.B. Clarke in J.D. Hook. , Fl. Brit. India 4: 425. 1884.

Specimen cited: Pradhanpat, 23.1.1989, *Das* et *Panda* 1340.

Fl. & Frt.: August-April.

Frequency: Rare.

Ecology: Only a few plants seen below Pradhanpat falls, in rock - crevices. Associated plants are *Phaulopsis imbricata* (Forssk.) Sweet, *Petalidium barlerioides* (Roth) Nees, *Pogostemon benghalensis* (N.L. Burm.) Ktze., *Ruellia tuberosa* L., etc.

NOTE: This collection of the species from Sambalpur district is a new record for the flora of Orissa and Eastern India. The species is endemic to India- Bangladesh- Myanmar region. In India, so far, the taxon was known to occur in Western and Peninsular India (Rajasthan, Maharashtra, Karnataka, Kerala).

Lobelia dichotoma Miq., Fl. Ind. bat. 2: 576. 1856; var. **dichotoma** : Haridasan et Mukherjee in Nayar *et al.*, Fasc. Fl. India 19: 48. 1988 (Lobeliaceae)

L. zeylanica C.B. Clarke in J.D. Hook., Fl. Brt. India 3: 425. 1881, incl. var. *walkeri* p.p.; *L. heyneana* Moeliono in van Steenis, Fl. Males. ser. 1, 6 : 129, *p.p.* 1960, *non* Roth ex Roem. et Schult.

Specimen cited: Bamra, 3.11.1986, *Das* et *Panda* 219.

Fl. & Frt. : October-April.

Frequency: Less common.

Ecology: Growing on moist loamy soil, in open waste places, in association with *Tridax procumbens* L., *Hybanthus enneaspermus* (L.) F.V. Muell., *Evolvulus alsinoides* (L.) L., *Euphorbia heyneana* Spreng., etc.

NOTE: The occurrence of the taxon in Sambalpur district results in a new report for Orissa, also for Eastern India: earlier it was recorded form Peninsular India (Karnataka, Kerala and Tamil Nadu), Sri Lanka, Java, Malaysia. The availability in Sambalpur, Orissa, may extend its range of distribution further to other directions of the country. However, the plant was seen only at Bamra, nowhere else in the district.

Murdannia pauciflora (Wt.) Brueckner in Engl. et Prantl, Pflanzenfam. ed. 2, 15a: 173. 1930; Gandhi in Saldanha et Nicolson, Fl. Hassan dist. 649. 1976 (Commelinaceae).

Aneilema pauciflorum Wt., Ic. t. 2077. 1853 ('Pauciflora'), *nom. illegit. non* Dalzell (Hooker's J. Bot. Kew Gard. Misc. 3: 136. 1851 = *M. vaginata* (L.) Brueckner; J.D. Hook. in J.D. Hook, Fl. Brit. India 6: 378. 1892.

Specimen cited: Hirakud, 24.8.1986, *Das* et *Panda* 103. Fl. & Frt. : July - November.

Frequency: Rare.

Ecology: Grows on moist loamy-lateritic soil, in open land, in association with *Murdannia nudiflora* (L.) Brenan, *M. hookeri* (C.B. Cl.) Brueckner, *Cyanotis cristata* (L.) D. Don, *Vernonia cinerea* (L.) Less., *Pouzolzia zeylanica* (L.) Benn., etc.

NOTE: This collection of the species from Sambalpur district, is new addition to the flora of Orissa, as well as Eastern India. A few plants were seen at Hirakud only. Earlier records are from Malaya and Southern India (Karnataka, Kerala, Tamil Nadu, Andhra Pradesh). The availability in Sambalpur, Orissa, extends its range of distribution to other parts of the country.

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September 15, 1992

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40. A NEW NAME FOR *BULBOPHYLLUM FLAVIDUM* LUCKSOM

S.Z. Lucksom (1993) published a new species of *Bulbophyllum,* namely *Bulbophyllum flavidum* based on collection from Lachung Valley and Phyangla R.F. (Sikkim). Perusal of literature revealed that the name *Bulbophyllum flavidum* is preoccupid being published by Lindley in Bot. Reg. Misc. 83. 1840 for a tropical African species. As per the Botanical code *B. flavidum* Lucksom (1993) is a non. illeg. being a later homonym of *B. flavidum* Lindl. (1840). Hence, a new name is proposed here for this species:

Bulbophyllum pantlingii Lucksom nom. nov. = *Bulbophyllum flavidum (flavida)* Lucksom in *J. Bombay nat. Hist. Soc. 90 (1):* 71. 1993 (non Lindley 1840).

The Species is named after Mr. Pantling the co-Author of the book the Orchids of Sikkim Himalaya, who infact has contributed a lot towards the exposition of the orchids of Sikkim Himalaya.

Thanks to Dr. C. S. Kumar, Tropical B. Garden, Trivandrum for valuable comments.

October 12, 1993

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ERRATUM

Vol. 90 (2)

MISCELLANEOUS NOTES

15. PATTERN OF BEAUTIFICATION BY BLACKTHROATED WEAVER BIRD *PLOCEUS BENGHALENSIS* (L.) IN EASTERN RAJASTHAN

Figure 1, on p. 293
and
Figure 3, on p. 294
are upside down.

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